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THE NAVAL OBSERVATORY ECLIPSE EXPEDITION, JUNE 8, 1918.

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(Communicated by Rear Admiral T. B. Howard, USN., Ret., Superintendent.)

The observation of the total solar eclipse of June 8, 1918, by the Naval Observatory was made possible by a special appropriation of $3500 by Congress. After considering various sites, it was decided to locate at Baker, Oregon. The weather conditions were likely to be good at Baker in June; also the altitude of the sun at the time of eclipse was greater and the duration of totality longer than at points farther east.

All the preparations were made during the winter of 1917-18 and the car containing the apparatus left Washington on April 11. The advance party consisting of astronomer J. C. Hammond, Assistants C. C. Wylie and W. A. Conrad of the Naval Observatory, and Dr. S. A. Mitchell, Director of the Leander McCormick Observatory of the University of Virginia, arrived at Baker on April 29. They were joined on May 1 by Professor L. G. Hoxton of the University of Virginia. These five members of the expedition set up and adjusted the various instruments. They were aided in this work by a party of six men sent from the Receiving ship at Puget Sound, Washington. This party consisted of Patrick Welsh, Chief Quartermaster, N. R. F., W. L. Veale, CM 1C, U. S. N., G. J. Pehling, MM 2C, N. R. F., and H. H. Herrick, Carl Krummel and F. Oleson, seamen U. S. N. These men reported on May 5 and remained until the instruments were all repacked for shipment back to Washington after the eclipse.

Baker is a thriving city of 9000 inhabitants, situated in the Powder river valley between two mountain ranges, the Blue or Elkhorn range on the west and the Powder river or Eagle Mountains on the northeast. Its altitude is about 3400 feet and the region is devoted chiefly to mining, lumbering, stock and fruit raising. Very comfortable quarters for the party were secured at the Hotel Antlers. Through the kindness

of the Mayor, Mr. C. L. Palmer, and Mr. S. O. Correll, an ideal site was obtained at the fair grounds which were located about a mile from the center of the city.

On May 1, 3, 4, and June 10, sextant observations of the sun were made by Mitchell and Wylie for a determination of the local time and latitude. These observations combined with the noon signals from Mare Island gave as preliminary values of the longitude and latitude of the station

$$\text{Long.} = 2^h\ 43^m\ 8^s.5 \text{ from Washington}, \quad \text{Lat.} = +\ 44^\circ\ 47'.9.$$

On the night of May 1, a meridian was laid out by observations of Polaris made with a surveyor's transit borrowed from the local county surveyor as the eclipse instruments had not arrived. Arrangements had been made with the Western Union Telegraph Co., for the use of their lines for an exchange of longitude signals between the eclipse station and the Naval Observatory and two pairs of wires were run to the station by the Western Union Co. These wires were also used for the receipt of the daily noon signals from Mare Island. A wireless receiving set, loaned by the Washington Navy Yard, was installed but no wireless signals were received. This was probably due to the fact that the antennae were not placed high enough to overcome the effect of the mountains. However this was of no consequence as the longitude exchange by the Western Union left nothing to be desired.

On May 6, the car with the apparatus arrived safely and the work of erecting the various instruments went forward rapidly. The weather during May was ideal for the work. The mornings and nights were usually clear but in the afternoons clouds frequently formed over the Blue Mountains on the west and drifted over the sky, which would often be overcast at 4 o'clock, the time when the eclipse was to take place. Windstorms also were prevalent in the afternoon filling the air with dust. No rain fell during the six or seven weeks the party was there. A Clark equatorial of 5 inches aperture, which was taken along to observe the contacts, was used on many nights in May to show objects of interest in the heavens to the people of Baker, who took advantage of this opportunity in great numbers, as many as two hundred persons visiting the station on some nights.

Longitude and Latitude.—The final longitude of the eclipse station was determined by means of a direct exchange of signals with the Naval Observatory over the lines of the Western Union Telegraph Co. The instrument for determining the local time at Baker was a Fauth transit of 3 inches aperture, which was equipped with a latitude level and used also for the determination of the latitude. The observations for time were made by Mr. Hammond and for latitude by Mr. Wylie.

The observations for time at the Naval Observatory were made by Mr. Frederickson with the 6-inch transit circle. The following results for longitude and latitude were obtained:

Date	Longitude from Wash.	Date	Latitude
1918	m s	1918	° ′ ″
May 16	2 43 7.21	May 27	+44 47 25.9
17	7.23	28	25.4
22	7.28	29	26.0
23	7.22	31	25.8
Mean	2 43 7.24	Mean	+44 47 25.8

The double transmission times were respectively 0.39, 0.38, 0.45 and 0.38 seconds.

Other members of the eclipse party arrived as follows: Assistant Astronomer George H. Peters of the Naval Observatory, on May 24; Dr. Paul W. Merrill of the Bureau of Standards, Mr. Edward D. Adams, his grandson Kempton Adams of New York and Mr. Howard Russell Butler of Princeton, N. J., on May 31; Professors Harriet Bigelow and Mary M. Hopkins of Smith College on June 2.

On the morning of June 8 the sky was entirely overcast. The limb of the sun could just be seen with the equatorial. About noon it began to clear somewhat. At the time of first contact there was a thin cloud over the sun but the contact was easily observed. As totality approached there were clear patches of sky near the sun and the clouds were moving in such a way that it seemed certain that the sun would be in a clear space during totality. This expectation was not realized, however, as a light cloud covered the sun during totality. Five minutes afterwards, the sun was in a clear space. The seeing was very steady and the photographs, while they do not show the outer and fainter extensions of the corona, give fine representations of the inner corona and prominences.

Contacts.—The contacts were observed by Mr. Hammond, who also gave the signal for starting after the second contact. The first contact was estimated to be late by 3 or 4 seconds and a correction of 3½ seconds was applied. The second and third contacts were well observed. The last contact was worthless as it was again cloudy. The observed and computed times of the first three contacts are:

Contact	Observed G. M. T.	Computed G. M. T.	O—C
	h m s	h m s	s
1	9 46 59.2	9 47 11.6	—12.4
2	11 3 49.5	11 4 4.0	—14.5
3	11 5 41.6	11 5 56.4	—14.8

The computed times are derived from data in the American Ephemeris. The correction to the computed times for Baker, as given by Arthur Newton in A. J. 733, is −12.5 seconds. The computed duration of totality was 112.4 seconds and the observed duration 112.1 seconds.

65-foot Camera.—This instrument was in charge of W. A. Conrad, who was assisted by W. L. Veale. The camera was horizontal and was directed toward the sunrise point. Light from the corona was reflected from a silvered glass mirror 10 inches in diameter attached to a coelostat controlled by clockwork. The lens was 7½ inches in aperture and the plates were double coated special coronal, 17x20 inches, made by the Eastman Kodak Co. The diameter of the sun's image on the plates is about 7¼ inches. Five exposures were made of 5, 15, 35, 15, and 5 seconds duration respectively. The accompanying photograph (Plate I) is exposure No. 4, of 15 seconds duration. It shows the many beautiful prominences, some of which extend to a height of 50,000 miles above the sun's surface, and the corona as far out as one-alf the diameter of the sun. The arching of the corona around several of the prominences is plainly noticeable.

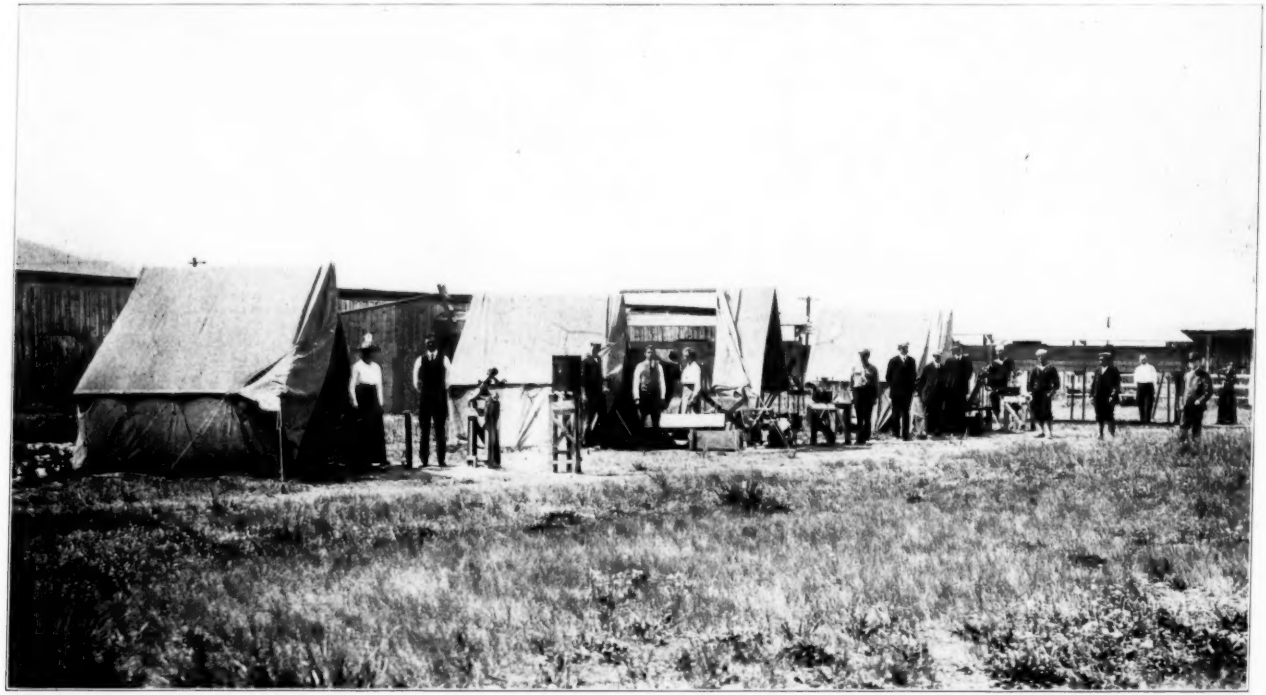
105-inch Camera.—This instrument was in charge of G. H. Peters who was assisted by Carl Krummel. The lens was a visual one of 6 inches aperture, used with a color screen and 8x10 inch Cramer Isochromatic plates. This camera was also horizontal and used with a coelostat carrying a mirror 7 inches in diameter. Three exposures were made of 15, 50, and 25 seconds duration to secure the middle portions of the corona.

33-inch Camera.—This instrument was in charge of C. C. Wylie, who was assisted by H. H. Herrick. The lens was a Dallmeyer portrait one of 6 inches aperture, and double coated special coronal plates 5x7 inches, made by the Eastman Co., were used. Two exposures of 65 and 40 seconds duration were made to secure the outer extensions of the corona. The haze which prevailed obscured these extensions and made the work of this camera practically valueless.

Spectroscopic Work.—The spectroscopic work was under the supervision of Dr. Mitchell, who had been a member of the Naval Observatory expeditions of 1900, 1901, and 1905. He had planned to duplicate the work of 1905 by using the same dispersion but to photograph on a larger scale and to extend the work to the red end of the spectrum. Three spectrographs were used, each equipped with a concave grating, and used without slit. Each instrument was mounted horizontally and light was fed to the grating by a coelostat.

1. The largest dispersion used was attained by a 6-inch Rowland 21½-foot grating, which was very brilliant in the first order, ruled with 15,000 lines per inch. This grating was loaned by Dr. J. S. Ames of the Johns Hopkins University. Films were used, 2x24 inches in size, coated by Dr. C. E. K. Mees of the Eastman Kodak Company with a special emulsion. An attempt was made to photograph the region

PLATE II



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from the violet about λ 3300 to the D lines. On the day of the eclipse, Dr. Hoxton made the exposures and the plate holders were handled by Miss Bigelow.

2. The second concave grating used was one belonging to the Naval Observatory. It was also of 6 inches diameter and 15,000 lines per inch but of 10 feet radius of curvature. The same box and plate holders were used which were employed by Dr. Mitchell in Spain in 1905, the dispersion being identical with that of the 1905 flash spectrum, where one millimeter was equal to 10.8 Angströms. Miss Hopkins shifted the plate holders of this instrument while Dr. Mitchell made the exposures. The region to be photographed was from wave-length λ 3900 to about λ 7200 in the red. The films used were 1½x14 inches in size.

3. A third instrument of small dispersion was used by Dr. Merrill in an attempt to photograph to long wave-lengths in the red. Dr. Merrill brought with him some dicyanin furnished by Director S. W. Stratton of the Bureau of Standards. It was hoped that with the use of this dye, there would be a continuation of the success attained by the Bureau of Standards in photographing the deep red, by obtaining photographs of the spectrum of the eclipse. The grating used was a 6-inch Rowland concave of 2 meters radius of curvature, 6318 lines per inch, and with ruled lines 3 inches in length. This grating was loaned by Dr. C. G. Abbot, director of the Astrophysical Observatory of the Smithsonian Institution. The first and second orders of spectra were very brilliant and both orders were photographed on films 1¼ inches in width. At the red end of the first order, Seed 30 emulsion films were used stained by dicyanin. The remainder of the films were coated as for the longer instruments. On eclipse day, Dr. Merrill was assisted in the exposures by G. J. Pehling.

The most important exposures for all these instruments were those which should photograph the "flash spectrum" both at the beginning and at the end of totality. The developed spectra were disappointing. With the 21½-foot grating spectrograph, only feeble traces of the stronger lines were visible. Even at the second flash, though the clouds were thinner they were still too dense to obtain anything with this large dispersion, in spite of the excellent grating with its brilliant first order. More satisfactory results were obtained with the medium instrument, the 10-foot grating. With it the prominent lines are shown from the K-line to the hydrogen H_α, the spectra being in excellent focus. These spectra, on the same dispersion with the flash spectra obtained in 1905, on account of the relatively shorter exposure caused by clouds, do not show the great wealth of lines of the 1905 spectra. Still undoubtedly much of value will be learned when an opportunity is had to discuss them in detail.

In spite of the brilliant spectra obtained with the small dispersion Smithsonian grating, the spectra did not show as many lines as were expected. Nevertheless they will supplement those obtained with the 10-foot grating.

Professor Howard of the Physics department of the Baker High school and Professor Whitman of the same department in the Pendleton High school volunteered to observe the shadow bands. None were seen however. Patrick Welsh counted the seconds during totality to guide the various observers in making the exposures.

An interesting occurrence was the appearance of the brilliant new star in Aquila. This was seen by Mr. Peters and Mr. Conrad on the night of June 8 and the discovery was communicated by telegram to various observatories in the country. It had however been dicovered earlier on the same night by other astronomers in the east.

Special mention should be made of the interest taken in the expedition and the assistance rendered it by the people of Baker. In particular, thanks are due to Mr. C. L. Palmer, Mayor of Baker, and to Mr. W. Meacham, secretary of the Commercial club, for the many courtesies extended by them, to the fair ground association for the use of their grounds and to Mr. L. A. Tibbals who loaned a small building in which were kept the chronometers, chronograph, wireless set, and other valuable apparatus. It is desired also to express appreciation to Representative C. N. McArthur of Portland for the keen interest which he took in the success of the expedition.

THE "BETTER LAND."

Is it where the geometer draws his base,
And elegant quadrics float through space,
Where the circular points are the open door,
And conics osculate evermore?
Not there, not there, my child.

Can it lie, perchance, in the active sphere
Of the highly technical engineer,
Who silent stands in the foremost place,
Hewing the path for the human race?
Not there, not there, my child.

It lies afar on the Z^1 plane
Conformal, mapped by a Cauchy brain,
Where genius sees with a complex i,
And the Spirit of Functions dwells thereby.
It is there, it is there, my child.

[By an anonymous student in the School for Mathematical Research at Edinburgh. *The Observatory*, June 1918.]

NOVAE.

VINCENT FRANCIS.

In this era of speed and high tension, the average man does not have time to contemplate or appreciate the wonderful things of nature about him, even those which are before him day in and day out, but sets them aside with the thought, if he thinks of them at all, that they are all part of the daily routine and that they take care of themselves, so why should he waste his valuable time bothering about them. The very fact that we exist, that we are endowed with intelligence, that we live on the earth and are supported by it, that we have day and night, summer and winter, caused by our movements around our gigantic parent, the sun, that the earth's motions as well as those of our sister planets, the comets and little meteors, are all controlled by this luminary, do not enter the average man's mind once in a dog's age. In spite of this, however, they are none the less wonderful, even the most commonplace of them.

But these facts, wonderful and important as they are, shrink to a mere nothing when compared with the grand scale upon which the universe is founded. When one gazes at the heavens on a clear, crisp, fall or winter evening, his vision is confronted with hundred of suns ranging from brilliant Sirius down to mere points of light scarcely visible, the majority of them probably larger than our own sun, and at distances from us ranging anywhere from four to thousands of light years, where a light year is the distance travelled by a ray of light in a year at the rate of 186,000 miles a second. Can he say that there is a more wonderful or grander sight? Then there are the nebulae, those patches of hazy light, only a few of which are visible to the naked eye, but for this none the less wonderful, most of them probably at even greater distances from us than the stars and covering enormous areas of space. Add to these an eclipse of the sun or moon and the occasional appearance of a brilliant comet with its beautiful tail reaching more than half way from horizon to zenith and one begins to doubt whether there is any limit to the wonders of nature, a glimpse of which is anybody's for the trouble of looking up.

There is another spectacular occurrence which is occasionally visible in the heavens, which although appearing less often than a bright comet or an eclipse and in a way which would not compel instant attention, as is the case with the two mentioned above, is a far more

momentous happening as regards the universe at large. This is the appearance of a brilliant star where a day or two before none was known to exist. Small stars of this kind appear every two or three years, but bright objects comparable with Vega or Sirius are very rare, only four, including the present one, having been seen in the last three hundred and fifty years.

That these objects caused awe and wonderment among the ancients is shown by records of stars brighter than Venus having been seen as far back as 134 B. C. For many centuries these occasional brilliant manifestations were objects of awe and suspicion among the peoples of the earth just as were (although on a much larger scale) the bright comets. Indeed it has even been thought by some that the star of Bethlehem might have been one of these objects. This idea, however, has been practically disproved, there being no records to corroborate such an occurrence.

Absolutely nothing was known about the reason for the appearance of novae until the study of Astrophysics was developed during the last century, although many surmises or conjectures were made. But such rapid progress has been made of late years in following this mystery that astronomers feel now reasonably sure of the causes.

It is known that the lightgiving properties of the myriads of suns that we see shining down upon us on every clear evening do not last forever, but like the life of human beings, although extending over immeasurably longer periods,—periods compared with which probably the life of the whole human race sinks to insignificance,—began at some definite time in the past and will continue until some date in the remote future.

It has been shown by the analysis of the spectra of these suns that they are not all alike by any means, but that the white and bluish stars show the greatest light and heat giving properties and the smallest density, and that there is a regular sequence continuing from the white and bluish stars, through the yellow to the red ones and that the nearer the red type a star is, the lower its light and heat per unit of surface, the greater the number of elementary substances in chemical combination in it and the greater the density.

These discoveries have led to the logical conclusion that the hotter and lighter suns are comparatively young and that the cooler and heavier ones are the old ones and are nearing the end of their period of visibility.

These statements are all very well as far as they go, but if the term of visibility of a star is limited, what was it before it became visible and what becomes of it after it ceases to shine?

For a long time it has been known that there were unexplainable dark patches in the sky commonly known as coal sacks. The application of photography to astronomy has made the presence of these dark areas much more pronounced. They appear for the most part in regions densely populated with stars. The edges are very distinct and very few stars if any are visible anywhere within them. They do not appear like the sharp black of the sky but look rather dull, as if some dark substance covered the sky in these regions blotting out all the stars behind it. In fact the shapes of some of these dark patches resemble those of some of the nebulae to such an extent that they are thought to be actually dark nebulae or vast stretches of nonluminous matter.

It has also been suspected that there are great numbers of dark bodies such as extinct suns hurtling through the universe. Indeed it has been calculated by some astronomers that there are more of this kind of suns than there are luminous ones. This is a point, however, that obviously can never advance beyond the conjectural stage.

Now, enormous though the universe is, (it has been recently estimated to be in the neighborhood of 10,000 light years in diameter) there are known to be so many millions of suns and other objects, both bright and dark, in it, and all traveling at inconceivable speeds (a mile a second being exceedingly slow), that inevitably a sun will either approach closely another one or a nebula once in a while, or actually collide with it. Such enormous masses as we know these suns to be must cause great tidal friction upon one another when they get so close together, and if they are in a sufficiently plastic condition their crusts will burst and the whole mass of one or both will instantly become a mass of flame. Of course if they come into direct contact they will immediately turn into intensely hot vapor, even if they are as dead as the moon previous to the collision. And again if a dark sun comes in contact with a dark nebula the enormous friction would likewise cause it to blaze forth just as the meteors do when they strike our atmosphere.

At the present time it is almost universally believed that one of he above mentioned occurrences is precisely what happens when a nova becomes suddenly visible where a night or two before absolutely nothing was seen to indicate the presence of any matter. And it is thought that a good many of the stars which shine so brightly may have had their birth in just some such way. Indeed the "initial catastrophe", which is spoken of so often with reference to the origin of our own sun, very probably occurred in a like manner.

Of course the large majority of nebulae visible to us are so enormous that they must have had their origin in some other way. For instance the great nebula in Orion could not have come into being in any such

way, but its evolution must have been very gradual indeed. And again the spiral nebulae, which are now beginning to be thought of as separate universes, must be well nigh eternal with the process of evolution going on within them perpetually, as is the case with the universe of which we have the most intimate knowledge. But there is one class of smaller nebulae called planetary, practically all of which probably came into being through collisions.

It certainly is an awe inspiring thought to think of this mighty stellar system, with its millions of suns dashing about in all directions at terrific speeds, some brilliant with the blush of youth, others not so dazzling, further along on their lives' journeys, while still others have almost reached the limit of visibility and have lived their lives; then to think of this latter class of suns, after they have passed from our vision, rushing on as dead worlds through the vast reaches of space for indeterminate periods. But these periods, although they may be exceedingly long can not last forever, for some day in the course of their travels these dark suns will come so close to other bodies,—possibly dark suns like themselves, possibly bright suns or possibly nebulous matter—that the mutual attraction will cause terrific outbursts or even collisions, and the combined masses will be reborn and will start afresh their stellar lives, appearing as novae to the rest of the universe. On the strength of this how can it be said that the life of creation is limited, that it had a beginning and will have an end? Cosmic life is indeed eternal.

As stated before, the earliest record of the appearance of a new star has been found in the Chinese Annals as far back as the year 134 B. C. This star, the records say, attained extraordinary brilliancy in the constellation Scorpio, being bright enough to be seen in broad daylight. It was said by Pliny that the spectacular appearance induced Hipparchus "the Father of Astronomy" to form his famous catalogue of the stars. Another brilliant nova is also recorded in the Chinese Annals as having appeared in Sagittarius in May, B.C. 48. This region of the sky seems to have been particularly favored by novae, they having been reported in either Scorpio or Sagittarius in the years A. D. 386, 393, 1011, 1203, and 1584.

It will be noticed that the above mentioned constellations are in or very near one of the most densely populated portions of the Milky Way. In fact, since the time of Tycho Brahe's star (which we will describe presently) there have been discovered some twenty fairly conspicuous novae, and every one has been in the Milky Way.

There seems to have been great uncertainty in deciphering old records, in determining whether these sudden bursts of light were actually new stars or comets. The first brilliant nova about which

there is absolutely no question is the famous star of Tycho Brahe which appeared in 1572. Tycho, although of course having no instrumental aid at that time, made very elaborate and detailed records of his observations, even to the exact location of the star.

This star, also known as the "Pilgrim Star", was first seen by Tycho while residing at his uncle's house in Scania, then a part of the kingdom of Denmark, but later united with the rest of Sweden, on November 11, 1572, in the constellation Cassiopeia, although it is said to have been seen by others a few days before, his name being attached to it on account of the careful study made of it by him. "While living" he tells us, "with my uncle in the monastery of Hearitzwadt, on quitting my chemical laboratory one evening, I raised my eyes to the well known vault of heaven and observed, with indescribable astonishment, near the zenith in Cassiopeia, a radiant fixed star of a magnitude never before seen. In my amazement I doubted the evidence of my senses. However, to convince myself that it was no illusion and to have the testimony of others, I summoned my assistants from the laboratory and inquired of them and of all the country people that passed by, if they also observed the star that had thus suddenly burst forth. I subsequently heard that in Germany wagoners and other common people first called the attention of astronomers to this great phenomenon in the heavens,—a circumstance which, as in the case of non-predicted comets, furnished fresh occasion for the usual raillery at the expense of the learned."*

The star, brighter than Jupiter when first seen by Tycho, increased quickly in brilliance until its light equalled or exceeded that of Venus at her brightest, "a statement which will be appreciated at its full value by anyone who has ever watched Venus when she plays her dazzling role of "Evening Star" flaring like an arc in the sunset sky."† At this time the nova was visible in broad daylight, and being circumpolar, never set, being visible every hour of the twenty-four. It soon, as is the case with all novae, began to fade. In December 1572 it was comparable again with Jupiter. From that time on it began to change color as it lost its light, first turning yellow, and then red as it disappeared from view in March 1574, having been visible to the naked eye in all sixteen months. It is said that Tycho's interest in astronomy was aroused by the appearance of this star.

Perhaps Tycho's star has received as much attention as in any other way from the fanciful attempts to identify it with the "Star of Bethlehem." To quote Professor Langley: "The evidence relied on is this, that

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* Percival Lowell, "The Evolution of Worlds" pp. 5-6.

† Garrett P. Serviss, "Curiosities of the Sky" p. 70.

bright stars are said to have appeared in this constellation repeatedly at intervals of from three hundred and eight to three hundred and nineteen years (though even this is uncertain) and as the mean of these numbers is about three hundred and fourteen, which again is about one-fifth of 1572 (the then number of years from the birth of Christ) it has been suggested in support of the old notion, that the star of Bethlehem might have been a variable, shining out every three hundred and fourteen or three hundred and fifteen years, whose fifth return would fall in with the appearance that Tycho saw, and whose *sixth* return would come in 1886 or 1887."* However, there is absolutely no evidence here, and unless some sound scientific facts can be found to uphold this idea, it might as well be dismissed as entirely fanciful. A belief, nevertheless, still exists in some quarters that novae may really be very extreme variable stars, as there are a number of these stars that undergo enormous fluctuations of light between maximum and minimum, in some cases increasing or diminishing in brightness several hundred and even thousands of times. The best known examples of this type of variable are Mira Ceti and η Argus, the former changing in brightness more than six hundred times during the course of certain of its periods, though not during every one, and the latter showing even greater changes, though of late years it has not exhibited much activity. Another striking example of enormous light fluctuations is to be found in the star χ Cygni which has a total range of nearly ten magnitudes, meaning that it shines 10,000 times more brightly at some times than at others.†

Another brilliant nova appeared in the year 1604, thirty-two years after the appearance of Tycho's famous star, and although not quite reaching the great brilliance of the latter, it is said at one time to have been as bright as Venus.‡ This star also remained visible for more than a year and interested the great astronomer Kepler so much that he made very careful observations and records of it, as did Tycho Brahe of the earlier star. This star which Kepler called the "New Star in the Foot of the Serpent"¶ was in the constellation Ophiuchus, and is known as Kepler's star on account of his interest in it.

From that time for nearly three hundred years, no really brilliant nova appeared in the heavens. However, a number of fairly bright and very interesting stars have burst forth during this period. In the year 1670, on June 20, a new star was discovered in Cygnus very near

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* Samuel Pierpont Langley, "The New Astronomy" p. 229.

† Arthur R. Hinds, "Astronomy" Home University Library Edition, page 174.

‡ David P. Todd, "Stars and Telescopes" page 266.

¶ Percival Lowell, "The Evolution of Worlds" page 7.

the head. It was then of the third magnitude, and during the two years that it was visible "it underwent several remarkable changes in brightness."* There may possibly be some doubt as to its correct position, as Sir Robert Ball speaks of this star as appearing in the constellation Vulpecula. †

There seems to be a lack of records of novae appearing in the eighteenth century and the next one reported visible to the naked eye was discovered by Hind in Ophiuchus in 1848. This star only reached magnitude 5.5, however.

In the year 1866 a remarkable nova appeared in the constellation Corona Borealis. It was discovered on May 12 of that year and in six hours time increased in brightness from invisibility to a star of the second magnitude.‡ For this reason it is known as the "Blaze Star".¶ Another bright nova appeared on November 24, 1876, and reached the second magnitude before it began to wane.

There are at least two cases known of new stars appearing in nebulae or star clusters. One was discovered in the star cluster Messier 80 in 1860, and another shone forth in 1885 in the Great Nebula of Andromeda. Neither of these stars, however, became brighter than the sixth magnitude and consequently were never visible to the naked eye.

A very interesting nova was discovered in Auriga by Dr. Anderson of Edinburgh, January 24, 1892, and although at its brightest it only attained a magnitude of 4.4 it certainly deserves mention. In fact it reached its maximum brightness entirely unobserved on December 20, 1891, over a month prior to its discovery, as was evidenced by photographs taken at Harvard of this region between December 10 and January 20.‖ The star remained visible to the naked eye until the first of April, and, although never becoming so visible again, brightened temporarily in August from the 13th to the 10th magnitude. It maintained this brightness for several years but during this time a nebula developed around it very much like the ordinary planetary nebula. It was shown spectroscopically that this star was at an enormous distance from us, and that in order to cause such a rise in brightness the indications point to "a probable collision, or at least a near approach of two vast gaseous bodies traveling through "interstellar space, with a relative motion exceeding 500 miles a second."§

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* David P. Todd "Stars and Telescopes" page 266.

† Sir Robert S. Ball, "A Popular Guide to the Heavens" page 54.

‡ Samuel P. Langley, "The New Astronomy" page 230.

¶ J. Ellard Gore, "Astronomical Curiosities" page 180.

‖ David P. Todd, "Stars and Telescopes" footnote 53 page 267.

§ David P. Todd, "Stars and Telescopes" footnote 53, page 268.

But the appearance of this star was to be far eclipsed a few years later by a sudden outburst, the brilliance of which had not been approached since the appearance of Kepler's star in 1604, nearly three hundred years previous. This star was also discovered by Dr. Anderson in the early morning of February 21, 1901. He tells how, after studying the stars for some time, he leaned back to rest for a few moments at twenty minutes of three. In so doing his eye happened to glance over the constellation Perseus, and there, not far from Algol, he saw a new star of magnitude 2.7.* That this star increased in brightness at least four thousand fold in a few hours is proved by the fact that on a photograph of the same region taken but twenty-eight hours previous to the discovery, showing stars nearly down to the twelfth magnitude, there was no trace of the nova to be found.† In a day and a half's time the star increased to the brightest star in the northern hemisphere, reaching zero magnitude. It then began to wane slowly, its light showing large fluctuations at frequent intervals and its color changing to yellow and red as seems to be the case with all novae

By the 1st of August, 1901, it ceased to be visible to the naked eye. At that time it showed a spectrum like a gaseous nebula, and it was not long before Wolf and Ritchey found traces of nebulous matter emanating in spirals from the star as a nucleus. On September 20 the nebula appeared to have a diameter of about fifteen minutes of arc or half that of the full moon, but on November 13 it had changed its form and perceptibly increased in size to a rectangle seventeen minutes by sixteen in dimensions. Thus the more pronounced parts of the nebula had moved outward from the center at the surprisingly high rate of eleven minutes of arc a year.‡ Astronomers differ as to the cause of this rapid movement. It is far too rapid to be the direct result of a collision or an explosion. Kapteyn advanced the theory that the star had run into a dark nebula, causing it to burst forth and that it was the reflection of the light traveling out into the nebula and thus illuminating it. The chief objection to this theory is that all parts of the nebula seemed to be moving outward from the star as a center in absolute conformity, which certainly would not be the case if it were an entirely separate body shining by reflected light and not caused by something inherent in the star itself.

Lowell has advanced a theory in explanation of this phenomenon which seems to the writer much more plausible, namely, that the particles which formed the nebula were very probably composed of

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* Arthur R. Hinds, "Astronomy" Home University Library Edition, page 171.

† Ibid page 172.

‡ A. and W. Maunder, "The Heavens and their Story" page 317.

hydrogen or some other light gas and that they were driven from the nova by the pressure of light.* By this theory many of the objections to the reflected light theory could be overcome.

Newcomb thinks that the star is at such an enormous distance that the area covered by the nebula in such a short time would mean a a speed even swifter than that of light. He thinks there may be some agency as yet unknown to science which might produce "an effect which shall travel yet faster than light" and he asks, "is there really anything intrinsically unprobable in an agency traveling with a speed many times that of light?"†

In estimating the distance of Nova Persei as at least two thousand light years and possibly two or three times this,‡ Professor Newcomb does not agree with the generally accepted distance of about three hundred light years. But just try to imagine what even this shorter distance of three hundred light years means. It means that "the outburst of the star actually took place about the time that Galileo first turned his telescope upon the heavens, and the news of this great stellar catastrophe, though speeding to us on the wings of light" (186,000 miles per second) "only reached us in the year 1901. It also means that seven months after the first outburst of the 'new star' the nebula was lighted up to a length and breadth of eight and a half millions of millions of miles, or about a third of the distance from the sun to Alpha Centauri."¶

This star, which caused such widespread comment and discussion for some time after its discovery, is still visible to us telescopically as a faint nebulous star of about the ninth magnitude.

From the time of Nova Persei up to the present year there has been but one nova of any consequence discovered. This appeared in 1912 in Gemini, was discovered by a Russian named Enebo and reached the third magnitude in brightness. It received a great deal of attention at the time of its appearance.

But the year 1918 will be a banner year in the history of novae, for on June 8 one was discovered which in a day or two was practically the equal of Sirius, the brightest star in the entire heavens. However, like all the rest of the novae, it soon started to fade, and at the present writing, two months after the discovery, it is a little brighter than the fourth magnitude. About the first of July it underwent quite a fluctuation in brightness increasing from magnitude 3.9 to 3.2, and again

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* Percival Lowell, "The Evolution of Worlds" page 16.

† Simon Newcomb, "Sidelights on Astronomy" page 27.

‡ Ibid., page 25.

¶ A. and W. Maunder, "The Heavens and their Story" page 318.

about the first of August according to the writer's observations, which have not been verified as yet, it suddenly dropped from magnitude 3.7 to 4.6, but returned again to magnitude 3.8 in a few days.

This star is undoubtedly receiving more attention and study than any nova ever has had, and the knowledge gained by its appearance ought to go a long way toward solving the problem of the sudden bursting forth of these bodies. It is indeed quite a coincidence that this star should have appeared on the very day of the solar eclipse, for which the astronomical world, particularly in the United States, was on the qui vive.

To sum up, we have found that all novae have practically the same characteristics. They appear in or very close to the Milky Way, or in a star cluster or nebula, where a few days or even a few hours before, there had been no star at all or only a very faint telescopic one visible. They reach their maximum brightness within two or three days of their appearance, when the spectroscope shows us that their light comes from glowing gas. Then they begin to fade, their color becomes yellow, and a gaseous nebula begins to form, and they gradually decline in brightness, with many fluctuations in their light, turning red until they become ordinary or possibly nebulous faint stars only visible in a good many cases in the largest telescopes. The length of time they are visible to the naked eye varies, of course, with their brightness at maximum, some never attaining naked eye visibility, some being so visible for but a few weeks, while at least one has been visible for nearly two years.

With the increase in the facilities for studying these objects and the organization and systematization of the observers and observations, the subject of novae is becoming of more and more interest all the time. A constant search for them is being kept up, for, although they do not appear as often as do comets, one is likely to be found at any time. Of course they are searched for almost entirely in the Milky Way, although the nebulae and star clusters are not neglected. In spite of the fact that they are discovered at the rate of only five or six a decade, the light from hundreds of them may be on its way towards us at this very moment, owing to the enormous distances that it must travel in order to reach us.

The sight of one of these wonderful objects bursting forth must bring into the minds of most people thoughts of what it may mean. It probably means the birth of a sun. This sun will undoubtedly at some far distant time contract from the highly attenuated gaseous mass it is at its birth. The matter thrust forth from it during the initial catastrophe may cool and condense and form planets revolving around their parent sun, and on one or many of these planets when they have

cooled sufficiently to have a stable crust, life may evolve and be supported, with possibly thinking beings like ourselves inhabiting them. Indeed in these cosmical cataclysms we have first hand evidence of the perpetuation of the Universe.

4 Sears St., New Bedford, Mass.

August 11, 1918.

THE INFLUENCE OF ASTRONOMY ON HUMAN THOUGHT.

REV. HECTOR MACPHERSON.

[*Continued from Vol. XXVI, page 704.*]

The Newtonian theory not only profoundly influenced astronomy and shaped its whole future course; it profoundly affected all human thought. (1) In the first place, Newton demonstrated the simplicity and unity of the known universe. The old idea of a radical difference between things celestial and things terrestrial,—already seriously damaged by the observations of Tycho Brahe and Galileo,—was now definitely refuted. The whole planetary system was seen to be ruled by one law. (2) In the second place, as Hoffding has truly remarked, "It was now clear that the fixed and law-abiding order of Nature prevails not only here on this Earth but also throughout the Universe." The world was now seen to be a huge machine. The scientific doctrine of the uniformity of nature, of which so much has been heard in philosophy and scientific thought, was now definitely established. (3) In the third place, the era of the mechanical conception had dawned: and this mechanical conception had an abiding influence over human thought. Hoffding has pointed out the remarkable connection between Newton's religious conceptions and his doctrine of mathematical physics,—a connection which arose through his concept of space as the organ by means of which God works as omnipotent in the world.

Newton proves, from the purpose and order in the world, the existence of God. The world is a great machine, set in motion by God, Who by supernatural means has arranged the masses, distances, and velocities of the planets; but the interference of God is required from time to time, owing to the irregularities arising from the actions of the various bodies on one another,—an idea which drew from Leibnitz the criticism that Newton had compared the universe to a clock, which required the constant interference of the watchmaker.

Deism in the religious sphere, conceived of God as external to His works, and the Newtonian cosmology in the hands of Newton, and more particularly his distinguished successors, and the popularizers of his system inevitably regarded the Creator in a similar light. Men such as Ferguson, and even Paley himself, never got beyond the idea of the world-system as a great mechanism. As Ferguson remarked,—"That the projectile force was at first given by the Deity is evident." Men such as Ferguson, Paley, and Thomas Dick would have been the first to repudiate the charge of Deism, and rightly so. Yet the mechanistic conception of the universe, prevalent in the eighteenth century, had a profound influence on higher thought, inasmuch as it prepared the way for Deism and commended it to the rational faculties. In the writings of the popularizers of Newton, we find a constant emphasis on design, contrivance and impelling power. There was a latent Deism in this cosmological concept, as is obvious from the remark commonly credited to Laplace,—"I have no need of the hypothesis of God."

(4) *Herschel and his Work.* The rise of the elder Herschel marked another great epoch in astronomical history. Astronomy had apparently settled down in fairly conventional-lines. One of the beneficial results of Newton's great work in science was the concentration of the minds of astronomers on the great task of the verification of the law of gravitation. Astronomical observation had for its end and aim the confirmation and perfection of the Newtonian theory, and so attention was directed chiefly to the bodies of the solar system, their motions and mutual perturbations. The stars were observed principally as convenient reference-points by which the positions of the moon and planets could be accurately fixed. In the course of these observations, several facts, it is true, were ascertained. Thus in 1718 Halley noticed that the stars Sirius, Aldebaran, Betelgeux, and Arcturus had perceptibly moved since the formation of the Ptolemaic catalogue. Efforts too were made to measure the distances of the brighter stars. In addition, isolated thinkers, Kant and Lambert in Germany, and Wright and Michell in England, speculated on the structure of the sidereal universe, and some marvellous intuitions were reached. But there were no data on which to base a theory of the cosmos external to our solar system.

This was the state of affairs when William Herschel appeared on the scene. He was not a great mathematician, and his work lay in the direction of making observations and systematizing the results which he derived from them.

Herschel's contributions to cosmological thought may be summed up under these heads: (1) He demonstrated, what other observers and writers had believed to be probable, the essential kinship of the

sun with the stars. In his bold and masterly paper contributed to the Royal Society of London in 1783, Herschel, making use of the proper motions of seven stars and separating what he believed to be their real from their apparent motions, reached the conclusion that the sun, carrying with it the planets and satellites, was moving towards a point in the heavens near to the star Lambda Herculis. Copernicus had shown that the earth, so far from being the center of the universe, was but one planet among others in ceaseless revolution round the sun. Herschel now proved that the sun itself was not the central body, but was merely one star among others in ceaseless motion through the depths of space.

(2) Herschel's investigations of double stars led him to the conclusion that the law of gravitation held sway throughout the depths of space. Newton had shown that the law ruled in the solar system, and his successors demonstrated that that law explained nearly all the irregularities of the planetary motions. From analogy it might have been supposed that the same law ruled the system of the stars, but there was no proof. When Herschel demonstrated that several double stars were in revolution round their common centre of gravity, he supplied the proof.

(3) Herschel's long-continued series of studies on the construction of the heavens did not result, it is true, in the solution of that problem. The famous disc-theory was put forward only to be abandoned, and when Herschel died, he left the problem further from solution than ever. But his researches did prove that the sidereal heavens constituted a greater system, of which the solar system formed part. And Herschel's researches demonstrated also the vast scale on which the universe was built. His first theory that star-clusters and nebulae formed universes external to our Galaxy implied an immense extension of the universe in space and time. In conversation with the poet Campbell in extreme old age, Herschel said truly, "I have looked further into space than ever human being did before me," adding more hypothetically, "I have observed stars, of which the light, it can be proved, must take two millions of years to reach this earth." The stupendous vistas opened up by Herschel's work had an enormous influence on contemporary thought. As Horace Walpole expressed it,—"One's imagination cracks." Herschel's epitaph in the churchyard of Upton, near Windsor, claims that "he broke through the barriers of the skies." It is no exaggeration to say that this is true. He revealed to mankind a universe of almost inconceivable vastness, ruled over by the law of gravitation. Compared to the extension of the universe in space which we owe to Herschel and his immediate successors, the Copernican revolution seems a very small affair.

THE EXTENSION OF THE UNIVERSE IN TIME.

This was by no means the sum of Herschel's work in astronomy, not only did he reveal greater vistas in space, he likewise had a share in the development of cosmogony.

Every ancient cosmology included a cosmogony. The early Greek thinkers undertook to explain not only the construction of the world, but also its origin. With the rise of a school of exact science, cosmology and cosmogony parted company. Hipparchus and his successors did not concern themselves with the origin of things, and so the idea of evolution or development which had made its appearance in the guesses of the Ionian philosophers was almost forgotten. After the conversion of the Roman world to Christianity, the Hebrew cosmogony contained in the first chapter of Genesis was accepted throughout Christendom as the final word in the method of creation. The theory of six literal days of Creation and a "carpenter God" was accepted without question for hundreds of years.

Curiously enough, it was a theologian, Ralph Cudworth, who in 1678, in his "Intellectual System of the Universe," argued against the prevalent mechanical theory of a literal and finished creation, and in favour of development in accordance with an immanent principle. In the eighteenth century our illustrious Scottish astronomer, James Ferguson, threw out a remarkable hint as to the building-up of the solar system as a result of gravitational action. "In the beginning," he said, "God brought all the particles of matter into being in those parts of open space where the sun and planets were to be formed, and endowed each particle with an attractive power, by which these neighbouring and at first detached particles would in time come together in their respective parts of space, and would form the different bodies of the solar system."

The nebular hypothesis, as we know it, originated independently in the minds of three men,—Kant, Laplace, and Herschel. Neither Laplace nor Herschel seems to have been acquainted with Kant's speculation or with the views of each other. Kant and Laplace proceeded on the deductive method. Their theories were pure speculations. Herschel was led by his observations of nebulae and nebulous stars to postulate the gradual development of nebulae into stars and planets. Laplace had declared that at one time the solar system had been in a nebulous or gaseous state. Herschel pointed out that such gaseous masses were actually in existence in the heavens, in all stages of evolution.

At first the nebular theory was received with indifference. Laplace had promulgated his view, diffidently, in the appendix of a popular book. Herschel published no books, and his gradually developing views were only to be understood by a study of his papers in the "Philosoph-

ical Transactions" of the Royal Society. Gradually the indifference died away. Theological writers and scholars opposed the theory bitterly, but there was also a scientific opposition, for the average scientist of the time was still at the stage of the mechanical conception of nature.

Slowly but surely the mechanical theory was passing away. Even in theology Deism was giving place to the new sense, which we find in Coleridge and Schleiermacher, of the Divine immanence; in philosophy the empiricism of the French school was giving way before the idealism of Fichte, Schelling, Hegel, and Goethe; and in physics the whole mechanical concept of empty space and isolated bodies was disappearing. In 1801 Thomas Young revived the wave theory of light, which assumed the existence of a luminiferous ether. Each of these developments had its effect upon human thought. The contribution of astronomy was the work of Herschel and Laplace in showing the possibility that the celestial bodies had arrived at their present condition in obedience to a process of evolution. Thus, astronomical science, no less than geological, enormously extended the period during which the universe had been known to exist.

Herschel's discovery of the solar motion had shown the sun to be in every respect similar to the other stars. His investigations of the construction of the heavens had shown that the stars actually formed a connected system. The new theory of light, by destroying the conception of empty space, assumed the unity of the universe. But this unity was first actually proved by the marvelous revelations of spectrum analysis.

The work of Fraunhofer, cut short by his early death, was carried forward by Kirchhoff, with the result that in 1859 the spectroscope became the adjunct of the telescope. In 1823 Comte had declared that one thing at least man could never know,—the chemical composition of the celestial bodies. In less than forty years the seemingly impossible had been accomplished. As a result the chemical unity of the universe was found to be a truth of nature. The cosmos was seen to be in very truth a cosmos, connected and inter-related in all its parts.

The history of astronomical science in the last half century has been the record of the triumph of telescope, spectroscope, and camera; as a result of the ceaseless labour of astronomers, several facts are tolerably certain today.

What is the form and extent of the universe? The problem is a very old one, and our conception to-day is not so definite as that of Herschel when he formulated his famous disc-theory of the stellar heavens.

In the first place, that collection of stars known variously as the Stellar Universe, the Sidereal System, and the Galaxy, although of vast dimensions, seems to be limited in extent. That the universe of stars is finite in extent may be proved by a calculation originally mentioned by the German astronomer Olbers, which was used with great force by Newcomb and Gore in their investigation of the extent of the stellar system. There are three times as many stars of any given magnitude as of the magnitude immediately brighter. Thus, the increase of number more than compensates for the decrease of brightness, and were the stars infinite in number, the whole heavens would shine with greater brilliance than the sun. It has also been shown conclusively that in certain portions of the sky observers have penetrated to the limits of the universe. In these parts large telescopes do not show more stars than smaller instruments, proving conclusively that, in these regions at all events, the universe is finite. It is true that the universe is very vast in extent. The photographs of Professor Max Wolf and Professor Barnard have revealed untold numbers of stars; nevertheless, the starry system seems to be strictly limited.

What of the extent of our universe? Various estimates have been made, and they differ considerably. These distances are generally measured, not in miles but in "light-years"—the number of years which light, travelling at the rate of 186,000 miles a second, requires to travel from the stars to the earth. Seeliger of Munich has calculated that the limits of the universe are about 9,000 light-years from the solar system—which is, roughly speaking, in the central region of the universe. Newcomb reached a smaller estimate—3,000 light-years. More recently, in 1911, after an elaborate investigation, See reached the conclusion that "the most remote stars are separated from us by a distance of at least 1,000,000 light-years." There is, therefore, little or no unanimity as to the actual extent of the sidereal system. It is very vast, though finite, and probably only one of a number of similar systems.

Have we any positive knowledge of such systems? Towards the close of the eighteenth century, the view that star-clusters and nebulae were "island universes," analagous to our Milky Way, enjoyed considerable popularity. In the nineteenth century, it fell into disfavour, and was very generally abandoned after the spectroscopic discovery of the gaseous nature of many nebulae. As a sweeping generalization, its abandonment was a necessity, for the irregular nebulae are not star-clusters, but masses of gas, and the star-clusters proper show a tendency to cluster on the Milky Way.

But all nebulae so-called do not show gaseous spectra. A numerous class—the famous spiral nebulae—have spectra which, despite individual

peculiarities, may be described as continuous. The view is gradually gaining ground that these so-called spiral nebulae are external universes, analagous to our Milky May. Professor Eddington of Cambridge, who has made the problem of the construction of the universe peculiarly his own, inclines towards the view. Spiral nebulae are difficult to account for on any other hypothesis. Not only are they differentiated from other nebulae by their continuous spectra; they do not obey the law of galactic concentration, and betray no affinities with early-type stars. "The island universe theory," says Eddington, "is much to be preferred as a working hypothesis; and its consequences are so helpful as to suggest a distinct probability of its truth."

(1) On the whole, the theory agrees with the theory of the universe, now widely held, that our stellar system is a spiral nebula. "The two arms of the spiral," says Eddington, "have an interesting meaning for us in connection with stellar movements." The universe appears, according to present-day astronomers, to consist of two great star-streams moving in different directions. On the spiral nebula theory the prevalence of motions in opposite straight lines is explained.

(2) As already mentioned, the spiral nebulae shun the zone of the Milky Way altogether. According to the island universe theory, this is explained. In that region the external universes are blotted out from view, not only by the star-clouds of the galaxy, but by vast tracts of absorbing matter.

At present, we can only say that the balance of evidence is in favour of the view that, not only is our stellar system limited, but that we can see beyond its confines to other similar systems at distances so vast that the mind is unable to comprehend them, so vast that light will require tens and hundreds of thousands, if not millions, of years on the journey. And we must remember that this collection of island universes, including our own, will in all likelihood form another and greater system of a higher order. Truly, as Richter says, "the spirit of man acheth with this infinity."

Thus, the astronomical view of the entire universe teaches us that it is a unity—one great system bound together by the law of gravitation—in continuous progressive development. The difference between the world-concept of today and that of the Middle Ages may be best realized by a comparison of the view of our earth's position then held with the view current today. The medieval cosmology placed the earth in the center of the universe; it was not only relatively but absolutely the most important part of creation. Sun, moon, and stars were created 6000 years ago on the fourth day of Creation, for the sole purpose of giving light to the earth's inhabitants. To-day, our view of our world's place is vastly different. So far from being the center of

the universe, the earth is merely one of the planets revolving round the sun, and by no means the largest. The sun itself—relatively vast though it is—is by no means the chief body of the cosmos; it is merely a rather subordinate star—one of five hundred million or more, merely one shining speck in the jewelled casket of heaven. Flammarion, in two short passages, brings out very clearly and impressively the utterly insignificant place which our world actually occupies in the scheme of things. Speaking of the celestial motions, he says,—"Such are the stupendous motions which carry every sun, every system, every world, all life, and all destiny in all directions of the infinite immensity, through the boundless, bottomless abyss; in a void forever open, ever yawning, ever black and ever unfathomable; during an eternity, without days, without years, without centuries or measures. Such is the aspect, grand, splendid, and sublime of the universe, which flies through space before the dazzled and stupefied gaze of the terrestrial astronomer, born to-day to die tomorrow, on a globule lost in the infinite night.

"Our science is but a shadow on the face of the reality. Infinity encompasses us, on all sides life asserts itself, universal and external; our existence is but a fleeting moment, the vibration of an atom in a ray of the sun, and our planet is but an island floating in the celestial archipelago to which no thought will ever place any bounds. Never lose sight of the fact that space is infinite, that there is in the void neither height nor depth, neither right nor left, and in time neither beginning nor end. We must understand that our conceptions are relative to our imperfect and transitory impressions, and that the only reality is the Absolute."

Conclusion.

Our subject has been "The influence of Astronomy on Human Thought." Let us notice briefly the chief influences exerted by astronomy.

(1) The old geocentric theory of the world had its basis in the ancient astronomy. (2) The revolution in astronomy associated with the name of Copernicus swept away the old conception of a central earth, and exerted a powerful influence on theology and philosophy as well as on science. (3) while all branches of human thought influence one another, it may be safely said that the epoch-making work of Newton exerted the greatest influence on intellectual activity in the seventeenth century. The conception of natural law and causality with which we of today are familiar has its origin in Newton's great law of gravitation, which has remained to this day the foundation of

all scientific work. Newton, as we have seen, profoundly influenced the whole course of astronomy. Not only so; the Newtonian concept of the solar system as a great machine had something to do with the rise and popularity of the Deistic movement in theology. (4) The work of Herschel had an influence only second to that of Newton. Herschel enormously extended the universe both in space and time. Not only did his telescopes reveal stars sunk in the very depths of space; by his wonderful intuition he grasped the great truth of evolution as the explanation of celestial phenomena, and so, from the mechanistic conception of the universe, astronomers were gradually led to view the universe as an organism, developing from within. (5) Finally, the work of Herschel and of the nineteenth-century astronomers have shown the universe to be a unity.

Schiaparelli once called astronomy "the science of infinity and eternity," and the description is just. These words are often used by philosophers and theologians; astronomy gives some definite sense of what they mean. The concepts of infinity and eternity are soul staggering, but they are less difficult than those of limitation of space and time. To the higher thought the chief contribution of modern astronomy undoubtedly is this sense of infinity of space and eternity of time. And theology, which fought for so long through its official representatives against Copernicus, Newton, and Herschel, realizes now that it has reason to revere the memory of the astronomers who first unveiled the great truths of the immutability of natural law, the unity of the universe, and its subjection to one great law of nature, the infinity of space and the eternity of time, for in the contemplation of these great themes, science, philosophy, and theology find their meeting-place, and the problems of heaven and earth blend in an eternal harmony

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HOMEWARD BOUND.

Due west the helmsman steers with skilful arm,
His ship is staunch, the sea untroubled, calm,
Far, far from land, no other vessel's light,
A cloudless, moonless, star-bespangled night:
Six bells ring clear!—the Dipper's suns now blaze
Below the Polestar's fixed and faithful rays
Which sparkle gem-like in the darkling dome
As westwardly a good ship sails for home.

CHARLES NEVERS HOLMES.

TWENTY-SECOND MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

[*Continued from Vol. XXVI, page 698.*]

A BRIEF DESCRIPTION OF THE 26-INCH EQUATORIAL INSTRUMENT OF THE NAVAL OBSERVATORY AND ACCESSORIES—CLARK MOUNTING AT OLD OBSERVATORY, WARNER AND SWASEY MOUNTING AT NEW OBSERVATORY.

By Asaph Hall.

A description of the 26-inch equatorial at Washington, with its dome and accessories, both at the old site and at the new site, to which it was moved and remounted in 1893. The paper was illustrated by slides and will be printed in Popular Astronomy.

ACCOUNT OF SOME OF THE SERIES OF SATELLITE OBSERVATIONS MADE WITH 26-INCH EQUATORIAL OF THE NAVAL OBSERVATORY.

By Asaph Hall.

The plan of measuring satellites with respect to one another, instead of comparing them directly with the planet, appears to be due to Bessel, who made relative measures with the Königsberg heliometer of Rhea-Titan, satellites of Saturn.

In many cases the gain in accuracy of measurement through this intercomparison is considerable. But if it is desired to obtain corrections to assumed elements, the labor of computation is increased very much, since it is necessary to solve for two sets of elements in the same computation instead of one.

At the Naval Observatory extensive series of relative measures have been taken of the satellites of Saturn, also of Titania-Oberon, satellites of Uranus.

The solutions for three oppositions, 1909, 1910-11, 1911-12, of the intercomparisons of the Rhea-Titan satellites of Saturn, show small positive corrections to the assumed semimajor axes of the satellites' orbits, and a consequent decrease of the mass of Saturn.

THE ORBIT OF THE SPECTROSCOPIC BINARY 19 LYNCIS.

By W. E. Harper.

The star 19 Lyncis, right ascension $7^h\ 15^m$, declination $+55°\ 28'$, magnitude 5.6, type B8, was announced a spectroscopic binary by Adams in 1911 from three plates whose appearance indicated that two spectra were present.

Thirty-seven plates have been secured here in the years 1915, 1916 1917 and 1918. Values of the period differing slightly from each other were possible from the first two season's plates but the last two seasons tied the period down to 2.25960 days. The remaining elements are

$$\begin{aligned} e &= 0.076 \\ \omega &= 126°.11 \\ \gamma &= +\ 7.37 \text{ km} \\ K &= 104.43 \text{ km} \\ T &= \text{J. D. } 2{,}419{,}031.632 \\ a \sin i &= 3{,}235{,}400 \text{ km} \\ \frac{m_1 \sin^3 i}{(m+m_1)} &= 0.26\ \odot \end{aligned}$$

While the lines λ 4549, λ 4481 and λ 3933 are occasionally measured, in addition to the hydrogen lines, yet none are of good quality and the probable error of a plate is ± 6.9 km per sec. The lines of the secondary are too weak and the measurements too uncertain to obtain the ratio of the masses of the two bodies.

THE ORBITS OF THE SPECTROSCOPIC COMPONENTS OF BOSS 5173.

By W. E. Harper.

This star, right ascension $20^h\ 03^m$, declination $+26°\ 37'$, magnitude 5.5, type A, was announced a spectroscopic binary by Adams in June 1915 from measures of three plates. He noted that the hydrogen lines showed great variations in width and intensity and suspected that both spectra were present.

The period and general form of the velocity curves were readily obtained in the autumn of 1916, but in the solution it appeared that the values of the velocity of the system derived from the two curves differed by 10 or 15 km. More plates were secured and while the discrepancy is still present, though somewhat lessened, the elements have been determined on the assumption of a common velocity for γ.

The probable error of a plate is for the primary ± 4.8 km per sec. and

for the secondary ±6.9 km per sec. All plates were measured twice with a considerable interval elapsing between measures.

The final elements are:

$$
\begin{aligned}
P &= 9.316 \text{ days} \\
e &= 0.012 \\
\omega &= 103°.15 \\
\omega_1 &= 283°.15 \\
K &= 78.49 \text{ km} \\
K_1 &= 86.31 \text{ km} \\
\gamma &= -13.04 \text{ km} \\
T &= \text{J.D. } 2{,}420{,}304.628 \\
a \sin i &= 10{,}054{,}000 \text{ km} \\
a_1 \sin i &= 11{,}055{,}000 \text{ km} \\
m \sin^3 i &= 2.27 \odot \\
m_1 \sin^3 i &= 2.06 \odot
\end{aligned}
$$

THE SPECTRUM AND VELOCITY OF NOVA AQUILAE No. 3.

By W. E. Harper.

Spectra of the Nova were obtained at Ottawa on 13 nights in June and 22 in July with the single prism spectrograph covering the region from λ 3889 to λ 5020. The velocity deduced from the sharp H and K lines of calcium is −19.1 ±0.7 km per sec., referred to the sun. The displacements of the broader absorption lines in its spectrum, identified with the enhanced lines of iron, titanium, magnesium and strontium, increased from June 9 to about the 17th. The increase can be represented by saying that considering the displacements as Doppler effects the radial velocity they represent changes from 1250 km to 1742 km, approach. It is not implied of course that these displacements are Doppler effects. The emission bands of hydrogen appearing on June 10 and increasing relatively to the continuous spectrum are from 40 to 50 angstroms wide and are at about the normal positions of the lines. An attempt is made to connect the changes in the spectrum with the oscillations in brightness during July.

THE VARIABILITY OF EROS IN 1900-1901.

By Margaret Harwood.

The measurement of the brightness of seven hundred fifty images of the asteroid Eros (433) on plates taken at the Harvard Observatory during the years 1900 and 1901 has recently been finisbed. The results show that Eros was varying almost all, if not all, of the time from November 1, 1900 to June 21, 1901. The range of variation fluctuated between 0.4 and 1.5 magnitudes; the maximum light remaining constant, but the minimum varying. The period appears to vary also, but it is to be investigated further.

NOTE ON THE SPECTROSCOPIC BINARY 55 URSAE MAJORIS.

By F. Henroteau.

A few spectrograms of this star taken by the writer at the Detroit Observatory led him to notice that it has a very interesting variable spectrum. The variations observed are conspicuous; in certain cases the star seems to belong to class A0 with only a few broad and diffuse lines, while after a progressive transformation the lines become sharper and a greater number of metallic lines appear in the spectrum, until the star may be taken as belonging to late Class A or early F. The above Ann Arbor spectrograms also give a range of about 35 km in radial velocities.

From later plates taken by the writer at the Lick Observatory, he found that when the lines are few and appear at first sight wide and diffuse, a more careful examination shows them to be very close double lines. The lantern slides reproduced from Lick plates show the changes very well.

We have then to do with a binary system in which the two components are visible. From the measures of the magnesium line at λ 4481 (which shows the doubling very well) on 26 plates taken by the writer at the Lick Observatory from 1917 July 2 to July 10 the following elements, which have evidently a very large probable error, have been derived.

	Primary	Secondary
P	$2^d.5$	$2^d.5$
K	38.5 km	54.5 km
e	0.11	0.11
ω	$173°.4$	$353°.4$
T	1917 July 2 18^h 20^m	1917 July 2 18^h 20^m
γ	— 3 km	— 3 km
$a \sin i$	1,315,000 km	1,862,000 km
$m \sin^3 i$	0.1230 $\odot$	0.0849 $\odot$

These elements give us an idea of the probable dimensions of the system and would need to be redetermined by using a two prism dispersion spectrograph.

About one hundred one prism spectrograms of 55 Ursae Majoris have been taken and measured by Dr. Jordan at the Allegheny Observatory but the slit widths being too great to separate the double lines no period has as yet been found for its velocity variation.

55 Ursae Majoris is not known to be a variable star; its magnitude is given as 4.78 in the *Harvard Annals*, Vol. 50 and 4.94 in the Potsdam catalogue. It is very possible, however, that a careful study of its brightness would reveal a small variation.

The variations in the appearance of the spectrum seem worthy of investigation. Possibly also interesting physical changes occur in the system.

NOTES ON THE LIGHT-CURVES OF XX CYGNI AND U PEGASI.

By Frank C. Jordan.

The Thaw refractor is especially efficient in extra-focal photometry because of its large aperture and photographically corrected lens. It can deal with stars from four to five magnitudes fainter than can be reached with the ordinary doublet.

XX Cygni is an example of a faint variable whose light-curve has been derived by this method. It varies in magnitude from 11.39 to 12.45, and requires an exposure of only 10 minutes. Several observers have found large variations in the form of the curve, especially at maximum, at various epochs, differences of as much as 0.4 magnitude at the same phase being observed. Variations have also been found in the time of maximum. Our curves show no appreciable differences in either of these elements, but observations have been made through only four epochs of maximum.

U Pegasi, a star of the β Lyrae type, has a principal minimum of 10.66 magnitude, a secondary of 10.58; the first and second maxima are respectively 10.06 and 10.08. Comparison with Wendell's visual observations shows a color index of about 0.75 magnitude, indicating an F8 spectrum.

A NEW METHOD OF DETERMINING THE COLOR OF A STAR.

By Edward S. King.

The lens of a telescope is covered with a piece of plate glass coated with a gelatin fim, which is stained, one half of the surface yellow, the other half blue. Images of the stars are then photographed out of focus on isochromatic plates. Therefore, each image appears as a disk, one portion of which shows the effect of the yellow light, the other the effect of the blue light. A comparison of the two halves of each image may be made with a photographic wedge or other similar means. Since the images are out of focus, the plate glass need not be of the finest optical properties. A piece sufficiently good was selected from various commercial samples by subjecting them to photographic tests when placed over the lens of the 8-inch Draper telescope. Slides were exhibited, one of which showed the marked difference in color of Vega and Arcturus. This method is only in the experimental stage, but it is hoped that useful results may be obtained by it.

PHOTOMETRIC RESULTS AT THE ECLIPSE OF JUNE 8, 1918.

By Jakob Kunz and Joel Stebbins.

An illustrated account was given of the preparations for observing the eclipse at Rock Springs, Wyoming. The sky cleared only two minutes before totality, but during the critical time the observing conditions were perfect.

The total light of the corona was measured with a potassium photoelectric cell, which has a maximum color sensibility at about wavelength 4700A. The corona was compared directly or indirectly with a standard candle, two electric lamps, the full moon, and with a definite area of the sky during totality and in full sunshine. An approximate reduction of the observations gives:

Corona = 0.6 candle at 1 meter
= 0.6 full moon
= 600 times circle of sky ½° diameter, 8° from eclipsed sun
= 0.1 times circle of sky ½° diameter, 8° from uneclipsed sun.

HUBBLE'S VARIABLE NEBULA IN MONOCEROS, N. G. C. 2261.

By C. O. Lampland.

At the Albany meeting of the American Astronomical Society several photographs, made with the 40-inch reflector of the Lowell Observatory, were shown of the variable nebulae N. G. C. 2261 and N. G. C. 6729. Since that time observations of these objects with the same instruments have been continued at every favorable opportunity in an effort to follow the rapid changes they undergo. In the interval from October 1917 to May 1918 about one hundred additional photographs have been made of the nebula in Monoceros (N.G.C. 2261). It is planned to observe this nebula for another season before undertaking an exhaustive examination and intercomparison of all the photographs.

Many parts of the nebula appear to remain permanent in position, form, and brightness. Changes in position and brightness of the variable nebulous detail does not always take place at a uniform rate, the activity apparently being much more pronounced and accelerated at certain times. There are intervals when the nebula appears to undergo no perceptible variations.

On photographs made in August 1917 new detail had made its appearance in the form of a ray from the nucleus with a nebulous mass at its outer end, this ray lying outside the preceding edge of the nebula as it appeared in April and gives the nebula as a whole a more flared appearance than the earlier images. This formation had developed in the interval when the nebula was too near the sun for observation.

When photographs of October 1917 are compared with photographs taken in the winter months of 1918 a distinct displacement of the nebulous mass at the extremity of the ray referred to in the preceding paragraph is evident in the direct examination in the comparator as well as from measurements. The position angle of the nebulous mass with reference to the nucleus increased about 8° in the interval from October 1917 to April 1918. The total displacement is roughly six seconds of arc, the greater part of which apparently took place between January and April.

The nucleus of this nebula is the well-known irregular variable R Monocerotis. It has undergone no very marked variation in brightness in the interval covered by the Lowell Observatory series of photographs beginning in March 1916.

In seeking for explanations of the remarkable changes exhibited by this nebula many interesting questions are raised. It is to be hoped that the extensive series of photographs will help to answer some of them. Dr. Slipher's interesting observations of the spectrum give us much valuable information and should be suggestive and helpful in further work. Accurate observations with powerful instruments for the parallax of this object are much to be desired.

A slide was shown with images of the nebula for several dates in the interval between March 1916 and April 1918.

VARIABLE STARS IN THE LAGOON (N. G. C. 6523) AND TRIFID (N. G. C. 6514) NEBULAE.

By C. O. Lampland.

For a number of years systematic observations of many of the well-known nebulae have been made with the 40-inch reflector of the Lowell Observatory. Included in this program are the Lagoon and Trifid nebulae and several photographs have been made of them every year since the beginning of this work. In the summer of 1915 a number of long exposure photographs were made of these objects and an examination of the negatives in the comparator at the time led to the discovery of several variables in the Lagoon Nebula, and additional variables have been found in it on photographs of later years. Scattered through the nebula there are at present eighteen objects marked as variable or probably variable. Some of these stars are easily observed as they are moderately bright and undergo a considerable range of variation. But a number of them are difficult, as they are faint and have only a small range of variation.

A faint variable was discovered in the Trifid Nebula this summer (1918). Its brightness is between the sixteenth and seventeenth mag-

nitude and the range of variation is a magnitude or more. Its position referred to the nucleus of the nebula is five seconds of time preceding and a little more than two minutes of arc south.

The positions and estimates of brightness of these stars will be published in a forthcoming paper.

I might add that these photographs were made largely for future use in measurements for proper motion and for the purpose of examining the nebulosity for possible changes. The variables are a by-product of this work.

SOME PHOTOGRAPHIC RESULTS OF THE LOWELL OBSERVATORY SOLAR ECLIPSE EXPEDITION.

By C. O. Lampland and E. C. Slipher.

In this report on the spectrum observations of the corona at the eclipse of the sun on June 8, 1918, Dr. Slipher has given a general account of the organization and work of the Lowell Observatory Solar Eclipse Expedition, except the part relative to the direct photography of the corona.

We give herewith a brief account of the instrumental equipment for these observations, the work planned for it, and a short summary of the observational results.

For large scale photographs of the brighter parts of the corona and prominences.

Two photographic objectives of five inches aperture and 38.7 feet focus, each having its separate tower telescope mounting. The exposures varied from one to forty seconds.

For the extensions of the corona outside of the parts recorded by the long focus tower telescopes.

12-inch reflector, 100 inches focus.
6-inch visual refractor, 90 inches focus.
5-inch photographic doublet, 35 inches focus.
4-inch visual refractor, 60 inches focus.
All mounted on one polar axis. The exposures varied from five seconds to forty seconds.

For the faintest extensions of the coronal detail and streamers.

Two extremely rapid short focus lenses, a Voigtlander Series III of 6 inches focus, f/a 2.3, and a Dallmeyer of 7 inches focus, f/a 2.7. Exposure throughout totality.

For recording stars in the vicinity of the sun.

Two lenses (called "intra-mercurial" in earlier eclipse work) of 3 inches and 3½ inches aperture and about 11 feet focus. Both instruments mounted on one polar axis. Exposure throughout totality.

The unfavorable sky conditions at the time of totality somewhat modified our exposure times from those previously planned on the supposition of a clear sky; especially was this the case for the more rapid instruments intended for photographing the outlying parts of the corona.

With these instruments we obtained in all twenty-six plates, eight of this number being taken with the long focus tower telescope. The plates used were Seed "30" with the photographic objectives and the reflector, and Cramer's Iso Instantaneous with color screens for the visual refractors.

We were agreeably surprised to find upon the development of the plates that so much coronal detail had been photographed. But there can be no doubt that the fainter outlying parts and streamers had been largely obscured or obliterated by the haze and light clouds. Another effect was the scattering of the brilliant light of the inner corona, as is shown by the considerable amount of it that fell upon the disk of the moon. The overflowing of the coronal light upon the edge of the moon is especially marked on the plates taken with the more rapid instruments.

The large-scale photographs with the tower telescopes show well the brighter parts of the corona and many prominences. In the longer exposures the coronal matter and streamers may be traced nearly a diameter from the limb of the moon and much delicate detail was recorded. The photographs with the more rapid, short focus, instruments bring out a somewhat greater extent of the corona, but not nearly so much as should have been expected under conditions of a clear sky.

The general shape of the corona on our plates appears to be roughly triangular, the apex on the east and the base on the west side, and lies between the maximum and minimum types. The petal-shaped forms of the coronal detail is especially marked on the west side, resulting from the rifts in the coronal matter, the strong coronal arches and the directions of some of the streamers. There are many conspicuous prominences, some of them large. Probably the most remarkable features of these photographs are the arches and ogives of the coronal matter enclosing the prominences, apparently showing the influence of the prominences upon the surrounding and superposed parts of the corona. The apexes of some of the arches are visible in one or more instances at distances of half a radius from the moon's limb.

Several slides of the photographs were shown, including general views of the corona with different instruments, and highly magnified sections near the limb of the moon where the more interesting prominences and coronal arches were found.

THE LIGHT-CURVES OF ELEVEN NOVAE.

By Henrietta S. Leavitt.

During the past year, Miss M. H. Vann, the first holder of the Edward C. Pickering Fellowship for Women, has been studying the photographic brightness of novae, both before and after discovery. She has observed eleven of these objects on all available plates. One of them T Coronae, was at its maximum before regular photographic work had been established, but irregular fluctuations of brightness have characterized it during the past twenty-five years. T Pyxidis has had two outbursts, in 1890 and 1902, respectively. RS Ophiuchi has shown large, irregular variations both before and since its remarkable outburst of 1896. Of the remaining stars on the list, all but one, Nova Aurigae, show common characteristics and they have been grouped together. The average deviation from the mean diminution in magnitude at any particular time after maximum is about ± 0.4 magnitude, but the individual peculiarities are such that the mean light-curve can be considered typical only in a very general sense. Three things may be noticed:—First, the striking fluctuations in Nova Persei No. 2, Nova Geminorum No. 2, and Nova Aquilae No. 3, which differ in detail for the three novae. Second, the rapid fading and comparative absence of fluctuations in Nova Geminorum No. 1, Nova Lacertae, and Nova Monocerotis. Third, the prolonged maximum, sudden drop of eight magnitudes, and later partial recovery of brightness in Nova Aurigae, which is in remarkable contrast to all the other novae discussed.

SOLAR AND TERRESTRIAL ABSORPTION IN THE SUN'S SPECTRUM FROM 6400 A TO 9400 A.

By W. F. Meggers.

The Porter spectrograph at the Allegheny Observatory was used in this work on solar spectrum analysis in the red and infra-red spectral regions. An excellent 7-inch plane grating with 95,000 lines was loaned by the Johns Hopkins University for this purpose.

Taking light from the east and west limbs of the sun, two spectra were photographed side by side in order that the absorption lines due to the earth's atmosphere could be distinguished from those due to the sun's atmosphere by the displacement of solar lines because of the sun's rotation. Photographic plates stained with pinacyanol and dicyanin were used, and good spectrograms were obtained between the wave-length limits 6400 A and 9400 A. Instrumental difficulties made it impossible to photograph waves longer than 9400 A with this appa-

ratus. Between the limits named about 2300 absorption lines were recorded and of this number about 1600 were shown to be of terrestrial origin. These results will be described in detail in the *Publications of the Allegheny Observatory.*

THE TOTAL ECLIPSE OF JUNE 8, 1918.

By John A. Miller.

There were exhibited the photographs made by the Sproul Expedition at Brandon, Colo. The principal instrument used there was a telescope of 9 inches aperture, 62½ feet focal length.

Particular attention was called to the apparent influence of the prominences upon the inner corona, as was exhibited by arches of coronal structure around the prominences. In some instances there were several of these arches resembling Gothic window effects surrounding the same prominences.

NOVA AQUILAE No. 3.

By R. M. Motherwell.

The following magnitudes of Nova Aquilae No. 3 were made with a 6-inch doublet by the extra focal method, each magnitude being the mean of three successive exposures on the one plate. The comparison star used in all the measures is BD +1°,3766, listed in Harvard Annals as of magnitude 5.04 and spectral type B5; color-index −.12. As this is the only bright star close enough to the Nova to be measured by the extra focal method the range of brightness when the Nova was at its maximum was too great to use this method. Focal plates were therefore taken between June 9 and June 17, but there is at present no equipment on hand for measuring them.

Date (G.M.T.)				Magnitude
	d	h	m	
1918 June	17	17	19	3.14
	18	18	20	3.19
	19	16	43	3.45
	29	16	47	3.56
July	3	17	25	3.15
	4	17	00	2.96
	5	18	00	2.93
	9	17	01	3.08
	11	17	34	3.53
	12	15	51	3.56
	13	18	54	3.28
	15	16	51	3.20
	17	16	28	3.33
	30	17	05	3.60
Aug.	1	17	17	4.24

12 LACERTAE.

By R. M. Motherwell.

Observations on 12 Lacertae have been continued since 1915 but very few nights have permitted the extension of observations over the entire period of $4^h\ 37^m$. All observations have been by the extra focal method, the comparison stars being 10 Lacertae and 8 Lacertae. The variability of the star is established beyond any doubt and at some maxima the range of variation is in good agreement with that of Professor Stebbins (i.e., .12 of a magnitude) but at other maxima the range is only .06 of a magnitude. The following table will show this. Further observations are necessary to establish whether these maxima alternate. Moreover the phase of the maxima varies when applied to the period of 0.1930885 days as determined by Young.

Date	Phase of Maximum	Range in Brightness
	d	m
1915 Nov. 7	0.124	0.065
1915 Dec. 1	0.079	0.11
1916 Oct. 1	0.089	0.065
1916 Oct. 29	0.146	0.11
1917 Nov. 7	0.047	0.05

All phases referring to J. D. 2420761.150 $+0^d.1930885$.

THE YALE INDEX TO STAR CATALOGUES.

By Margaretta Palmer.

In these days of "conservation" perhaps we can draw forth from our astronomical attics materials that will be time-savers for other astronomers. It is the purpose of this paper to call attention to some material of that sort.

In the *Astronomical Journal*, No. 714, there appeared a short notice of a work which, for lack of a better name, we have called the *Yale Index to Star Catalogues*; perhaps *Concordance of Star Places* would be a true description. It consists of an interleaved copy of the *Bonner Durchmusterung* on the blank interleaves of which have been inserted references to nearly all of the useful star catalogues previous to 1900. If one wishes to find how many times any star contained in the B. D. has been observed and by whom, he will find this information in the *Index*. It is then a very simple matter to turn to the one, two, three, or any number of catalogues in which the star is found and make such use of the observed star positions as suits his purpose. He is thus spared the labor of fruitless search through many catalogues for a star whose position is found in only a few.

For some reason a star becomes interesting, as was the case with Barnard's proper motion star. Dr. Crommelin looked up the past history of that star, giving his results at the meeting of the Royal

Society, January 1917. With his knowledge of star catalogues Dr. Crommelin knew within certain limits which catalogues it would be necessary to consult so, probably, did not waste a great amount of time in fruitless search. He found the star in two catalogues, Lamont's and Bauschinger's. A glance at the *Yale Index* shows the entry for B. D. + 4°.3561 as Ma Mb, the abbreviations for the two Munich catalogues mentioned.

In selecting abbreviations, one of the chief requisites was brevity and, for that reason, the symbols used differ, in most cases, from those generally employed. As however, they follow a definite plan, the key is quite simple.

If it is desired to investigate the recorded positions of any star or group of stars, the *Index* furnishes immediate assistance, as will readily be seen by examining the duplicate sheets and key prepared for inspection.

This *Index*, begun in connection with the Yale parallax work, has never been completed for publication, but has reached the stage where its results may be of service through correspondence. As previously stated in *A. J.* No. 714, the Yale Observatory will, upon application, furnish such information as the *Index* contains in regard to any particular star or list of stars.

SPECTRA OF THE SOLAR CORONA AT THE ECLIPSE OF JUNE 8, 1918.

By J. A. Parkhurst.

Slides were shown from negatives taken at Green River, Wyoming, using objective-prisms of 15° and 30° angle in connection with a Brashear reflector of 6 inches and a Zeiss camera of 5.7 inches aperture, respectively. The exposure times were 30, 15, and 5 seconds with the 15° prism and the reflector, and 30 seconds with the 30° prism and Zeiss camera.

A Cramer isochromatic plate was used with the reflector and a Seed 30 plate with the camera. Slides of the spectral intensity curves of these plates were shown.

The isochromatic plate taken with the reflector showed a very strong image of the inner corona in the light of the green coronal line of wave-length 5303 A. The many prominences of the sun's limb showed their characteristic series of bright lines from D_3 far out into the ultra-violet, at least to the wave-length 3400 A.

The 30 second exposure on the Seed plate with the Zeiss camera showed the prominences in the photographic region, and also the strong coronal spectrum consisting of overlapping rings or continuous spectrum.

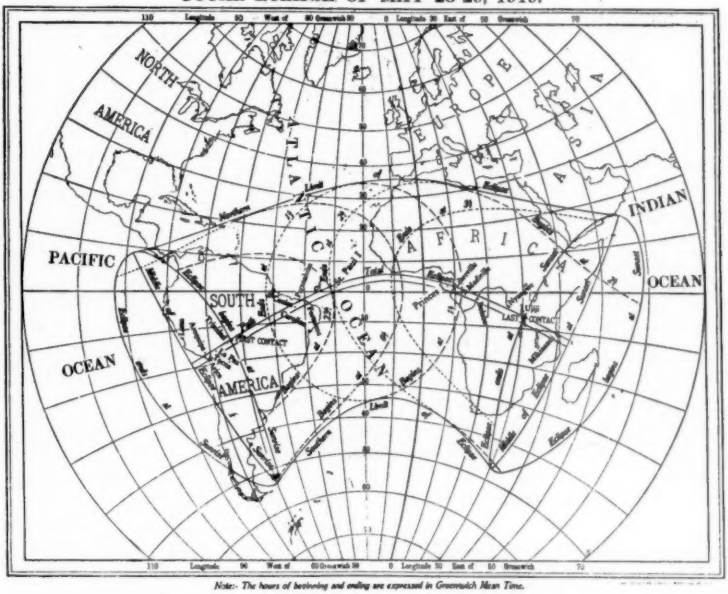
(*To be Continued.*)

ASTRONOMICAL PHENOMENA IN 1919.

Eclipses.

In the year 1919 there will be the same number of eclipses as in 1918, two of the sun and one of the moon. The first will be a total eclipse of the sun on May 28-29. This total solar eclipse will not attract the attention of observers in the United States as the total solar eclipse of June 8, 1918, did, since this one will be invisible at Washington and throughout the United States and in fact all of North America. The accompanying diagram shows the path of totality to extend across South America, the south Atlantic and the southern part of Africa. The line of the northern limit of visibility of the eclipse as a partial eclipse passes through Gibraltar and a little to the north of the Panama Canal. The point in the path of totality most easily reached by observers from North America is probably the east coast of Brazil. This, however, is a long distance to go and it is not likely

TOTAL ECLIPSE OF MAY 28-29, 1919.



Note:- The hours of beginning and ending are expressed in Greenwich Mean Time.

that many, if any, will travel so far, coming, as this eclipse does, so soon after the one which crossed the United States last June. However, astronomers have traveled much greater distances than this to observe a total eclipse of the sun.

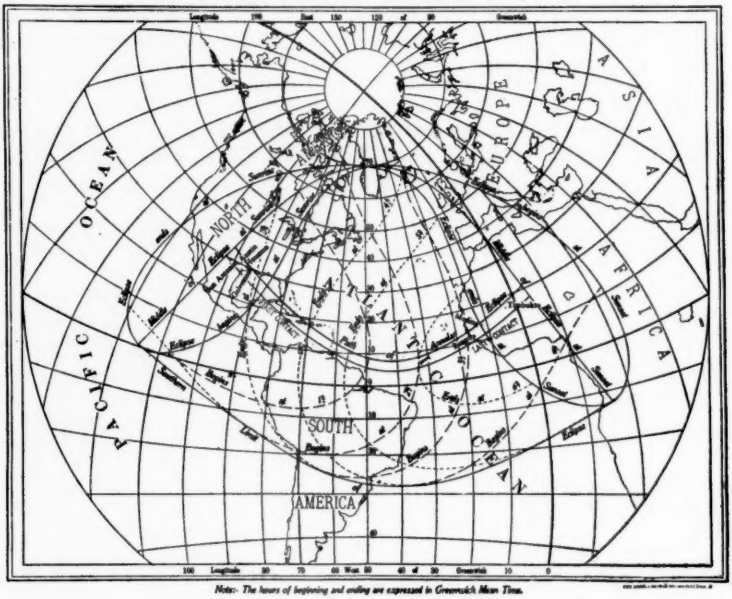
The remarkable feature of this eclipse is the duration of totality. In longitude 16° 28.8 west of Greenwich the maximum duration of 6 minutes 50.6 seconds occurs. This unfortunately is in the Atlantic ocean, but even on the African and South American coasts totality lasts between 5 and 6 minutes.

The circumstances of the eclipse are as follows:

		G. M. T.			Long. from Greenwich		Latitude	
		d	h	m	°	′	°	′
Eclipse begins	May	28	22	33.5	+63	27	−14	6
Central eclipse begins		28	23	30.1	+75	9	−19	43
Central eclipse at local apparent noon		29	1	6.6	+17	23	+ 4	18
Central eclipse ends		29	2	47.4	−42	27	−12	25
Eclipse ends		29	3	44.0	−30	36	− 6	46

The second eclipse will be a partial eclipse of the moon on November 7. This eclipse will be visible at Washington and generally throughout North and South America except in the western parts.

ANNULAR ECLIPSE OF NOVEMBER 22, 1919.



Note:- The hours of beginning and ending are expressed in Greenwich Mean Time.

The circumstances of the eclipse are as follows:

	d	h	m	
Moon enters penumbra Nov.	7	9	33.6	G. M. T.
Moon enters umbra	7	10	58.3	"
Middle of the eclipse	7	11	44.1	"
Moon leaves umbra	7	12	29.9	"
Moon leaves penumbra	7	13	55.0	"

Less than one-fifth of the moon will be eclipsed.

The third eclipse of the year will be an annular eclipse of the sun on November 22. An annular eclipse occurs when the moon passes between the sun and the earth at a time when the distance between the earth and moon is so great that the shadow cone cast by the moon does not reach the earth. To observers on the earth then the angular diameter of the moon is smaller than that of the sun, and consequently the moon will be seen as a dark circle against the disc of the sun but will not completely cover it. There will be a ring of sunlight, which gives the reason for the name. As in the case of a total solar eclipse, the path in which an annular eclipse is visible is comparatively small, and at points outside the path the eclipse will appear as partial. This eclipse will be visible as partial in northern Africa, western Europe, the Atlantic ocean, and the greater part of North and South America. The path of the annular eclipse, as seen in the diagram, extends from a point near San Antonio, Texas, through the Gulf of Mexico, skims along the northern boundary of South America, across the Atlantic Ocean, and ends in the interior of Africa.

The circumstances of the eclipse are as follows:

	G. M. T.			Long. from Greenwich		Latitude	
	d	h	m	°	′	°	′
Eclipse begins Nov.	22	0	14.4	+ 88	35	+22	11
Central eclipse begins	22	1	28.0	+102	31	+31	41
Central eclipse at local apparent noon	22	3	7.6	+ 50	24	+ 7	18
Central eclipse ends	22	5	0.1	— 4	11	+19	11
Eclipse ends	22	6	13.7	+ 10	25	+ 9	33

The diagrams, as well as the data of the eclipses, are taken from the *American Ephemeris* for 1919.

The Planets.

As in former years the paths of the planets among the stars during the year have been plotted and are shown here in Figures 1 and 2. The work on these diagrams was done this year by Mr. Donat Kazarinoff, Instructor in Mathematics in Carleton College. It will be remembered that the sun moves eastward in the sky at the rate of two hours a month on the average, starting at 0^h at the time of the vernal equinox on March 22. The position of the sun on the ecliptic can therefore readily be determined on any given date. For example, the sun will pass directly south of the Pleiades, whose right ascension is $3^h\ 40^m$, a little less than two months after March 22, about May 15. The diagram shows that Mercury will be about $1^h\ 30^m$ west of this point at this time and will therefore rise before the sun. Venus will, however, be found more than two hours east of this point at this time and will therefore be visible in the western sky after sunset. The method of using the diagrams is therefore evident.

Mercury begins its course on January 1 in the constellation Ophiuchus and moves eastward until April 1, when it turns and almost retraces its path for a time in Pisces. It then makes a graceful curve and on May 1 is again well started eastward. In August it describes a loop in Cancer, then moves eastward again until December when its path forms another cusp, and ends the year at a point very near where it began. Mercury will be too near the sun to be visible near the following dates: February 23, April 7, June 11, August 15, September 26, and December 2. It will be visible in the morning sky near the following dates: January 7, May 5, September 1, and December 21; in the evening sky near the following dates: March 21, July 18, and November 12. Mercury when at its greatest distance from the sun in the sky is visible without a telescope.

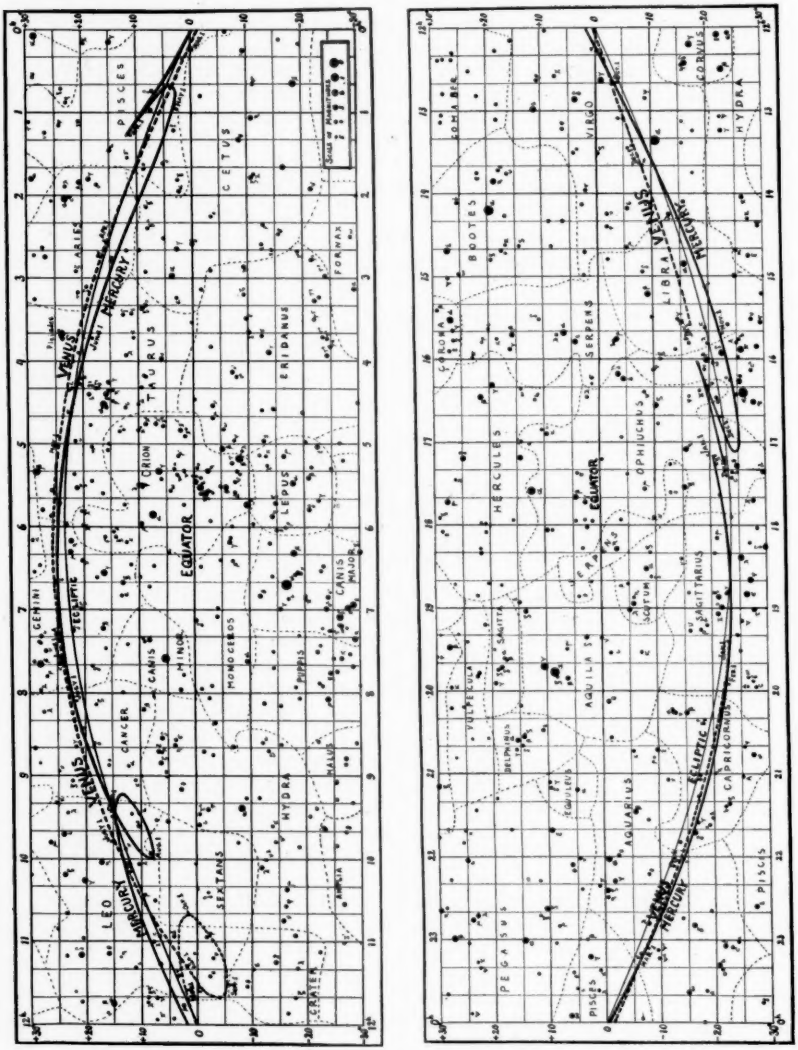


FIG. 1. Apparent paths of the planets Mercury and Venus among the stars during the year 1919.

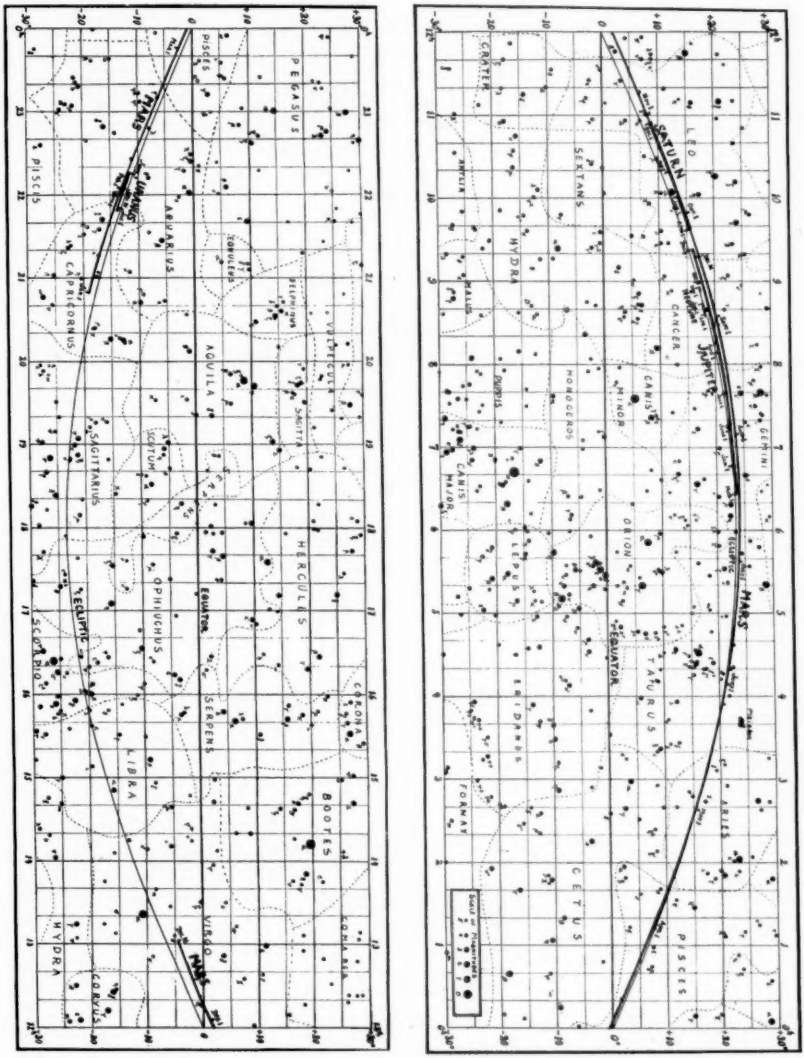


FIG. 2. Apparent paths of the planets Mars, Jupiter, Saturn, Uranus and Neptune among the stars during the year 1919.

Venus will start the year in Sagittarius and move steadily eastward throughout the year except in September when it describes a loop in Leo. It will precede the sun eastward and reach a point of greatest eastern elongation on July 4. It will therefore be a brilliant evening star until this date and for more than a month after this date. It will reach its greatest brilliancy on August 7. At this time its stellar magnitude will be —4.2. On September 12 it will pass between the sun and the earth. It will then become a morning star and reach a point of greatest elongation west on November 23, and be visible in the morning for the rest of the year. Venus will therefore be visible nearly the entire year.

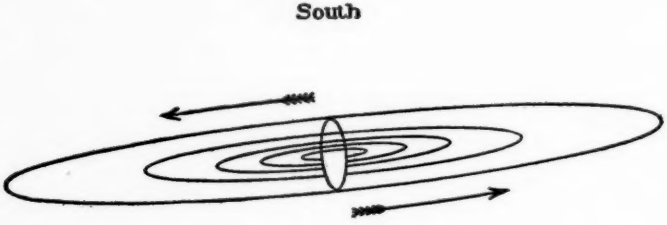


FIG. 3. Apparent orbits of the satellites of Jupiter at the date of opposition, January 1, 1919, as seen in an inverting telescope; elongated in the ratio of three to one in the direction of their minor axes.

Mars will begin the year in Capricornus and have an uninterrupted course eastward throughout the year, and end the year in Virgo. It will not come to a point of opposition during 1919. It will be low in the west at sunset at the beginning of the year. On May 9 it will be in conjunction with the sun and will not be visible for about two months following this date. It will be moving less rapidly than the sun and will consequently lag behind and therefore rise earlier from day to day. From September 1 to the end of the year it will be favorably situated for early morning observations.

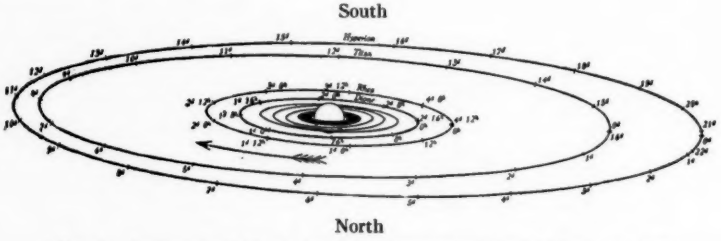


FIG. 4. Apparent orbits of the seven inner satellites of Saturn at date of opposition, February 14, 1919, as seen in an inverting telescope.

Jupiter will begin the year with retrograde motion in Gemini. On March 1 it will turn and move eastward through Cancer into Leo. It will be in opposition

with the sun on January 1, will be on the meridian at sunset on March 28, will be in conjunction with the sun on July 20, and will be on the meridian at sunrise on November 10. It will end the year with retrograde motion in Leo.

Saturn moves back and forth in Leo on an arc of a little more than fifteen degrees. It is in favorable position for observation at the beginning of the year, being at opposition with the sun on February 14. On May 13 it will be on the meridian at sunset. On August 25 it will be in conjunction with the sun, and hence will not be visible for about a month before and after this date. It will then become a morning star again and by December 4 will reach the meridian at sunrise.

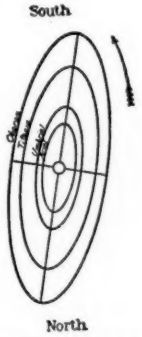


FIG. 5. Apparent orbits of the satellites of Uranus, at date of opposition, August 23, 1919, as seen in an inverting telescope

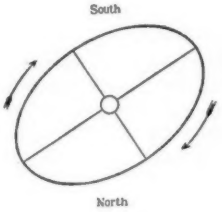


FIG. 6. Apparent orbit of the satellite of Neptune, at date of opposition, January 28, 1919, as seen in an inverting telescope

Uranus describes a short path near the boundary between Aquarius and Capricornus. It will be in conjunction with the sun on February 16. By April 1 it will be well out from the sun again and be in the morning sky. It will be in favorable position for evening observation in the latter part of the summer and early autumn.

Neptune will be found in the constellation Cancer. It will be in opposition with the sun on January 28, and will be in conjunction on August 1. It will therefore not be visible in the latter part of the summer.

Uranus under the most favorable conditions may be seen with the naked eye, but Neptune can be seen only with a telescope. It is rather difficult to distinguish these distant planets from the stars. Careful observation will, however, reveal motion which will indentify the planets.

The figures here given showing the orbits of the satellites are copied from the *American Ephemeris* for 1919.

COMETS.

Of the comets which are visible now, Wolf's periodic, Borrelly's periodic and Schorr's new comet, all will doubtless be followed for some time during the year 1919, with large telescopes. They will be too faint for amateurs to study.

Of the periodic comets which are to return to perihelion during this year

only one, Finlay's, will be under such conditions that it will be practically certain to be found. It is due at perihelion about Oct. 8 and will pass quite close to the earth, so that it should be a bright object at least in the telescope.

The Tempel-Swift comet is due in February and the Holmes comet in December, but these will be unfavorably situated unless their elements have been considerably changed by perturbations.

Kopff's comet 1906*e* was not seen at its return in 1913, but is due this year under better conditions, about July 16. It may be found with a large telescope or by photography, but will be a faint object at its best.

Bardard's comet 1892 V, Brooks' 1886 IV, and Giacobini's 1900 III are due under unfavorable circumstances and, as they have not been seen at the intervening returns, it is not very likely that they will be picked up.

Meteors.

The appearance of a meteor or "shooting-star" always attracts attention and excites comment on the part of one observing it. This is doubtless due to the suddenness and the unexpectedness of the phenomenon. Those who notice only the casual ones which appear on almost any clear night are apt to conclude that the phenomenon is relatively infrequent. Meteors are, however, striking the earth's atmosphere constantly although it is true that they do not all become visible. It is an interesting diversion to devote a few hours from time to time to counting and noting the directions of the meteors. At certain seasons especially they will be seen to emanate or radiate from very definite regions. Such meteors are said to form "showers" and the points from which they come are called their "radiants." These radiants remain practically the same from year to year.

The following are taken from the list prepared by Mr. W. F. Denning and published in the *Companion to the Observatory* for 1918. The average number to be expected for the night is also given.

Date	Radiant α	Radiant δ	Average Number
	°	°	
Jan. 2	230	+52	18
Jan. 3	230	+52	28
Apr. 20	270	+33	8
Apr. 21	271	+33	9
May 4	334	— 2	6
Aug. 10	44	+57	48
Aug. 11	45	+57	69
Oct. 19	92	+15	21
Oct. 20	98	+14	20
Nov. 14	150	+22	20
Nov. 15	150	+22	21
Nov. 19	25	+43	15
Dec. 11	111	+33	22
Dec. 12	112	+33	23

Variable Stars.

The predicted times of the maxima of a list of about eighty short period variables and of the minima of about one hundred others have been computed for the year 1919, from elements collected from the various published results of observations of these stars. The predicted times will be published as heretofore

one month in advance. The variation in the brightness of a star is a phenomenon which has called forth a number of explanations. The real impressiveness of such variation is felt only upon actually observing it, and not from mere reading about it. Any one with even a small telescope or opera glasses might select one of the brighter stars or one without a telescope might select a conspicuous naked eye variable such as Algol, and see the change take place. In doing so he would undoubtedly experience an unusual pleasure and feel that he had actually entered into a new acquaintance with the stars.

The observations of the long period variables made by the members of the American Association of Variable Star Observers will also be published from month to month as before.

Occultations.

The *American Ephemeris* publishes annually the stars which will be passed over, "occulted," by the moon. The list of occultations which are visible at Washington, and hence in general throughout the United States, will be reproduced from this source from month to month for the convenience of those who may not have access to the *Ephemeris*. To have a fixed star as a point for comparison, and then to see its light suddenly extinguished by the swift passing of the moon before it and to see it reappear at the other edge of the moon will enable one to grasp more clearly the fact of the actual and ceaseless motions of the celestial bodies through space.

Satellites.

Whenever Jupiter or Saturn or both are in favorable position for observation the list of the phenomena of their satellites as published in the *American Ephemeris* will be reproduced. These satellites are bright enough to be seen through even small telescopes and the changing of their relative positions from night to night will be a matter of interesting study for the amateur.

PLANET NOTES FOR FEBRUARY, 1919.

The sun will continue its journey northward during this month, moving from −17° 18′ to −8° 15′. Its path for this month lies in the constellations Capricornus and Aquarius.

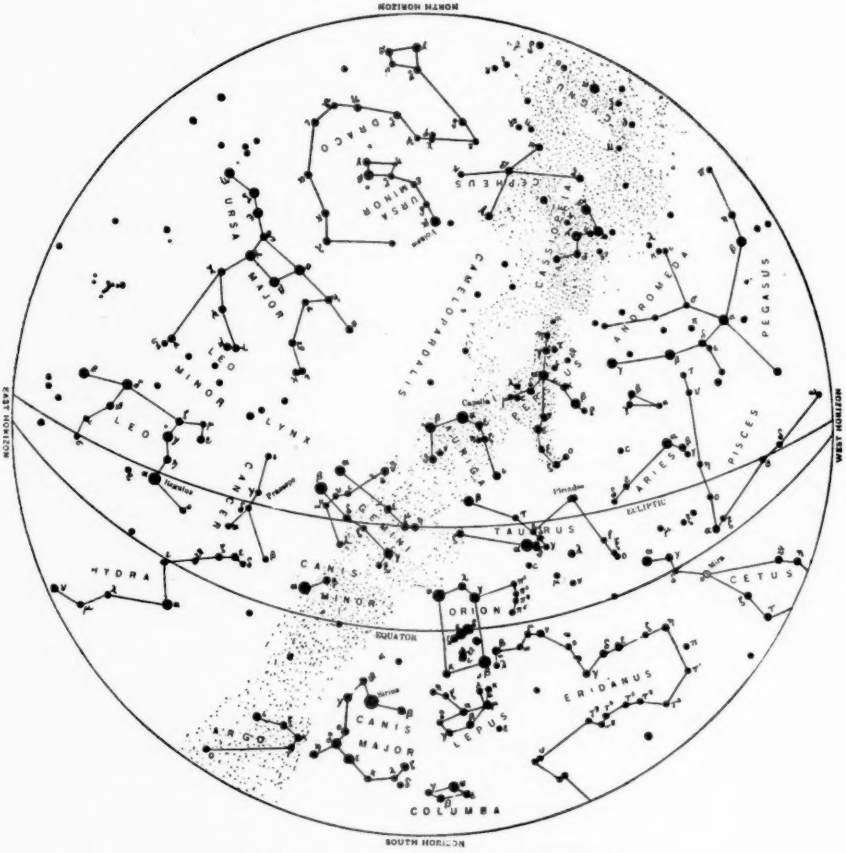
The phases of the moon for this month are as follows.

First Quarter	**Feb.**	**7**	**"**	**1 P.M.**	**"**
Full Moon		**14**	**"**	**6 P.M.**	**"**
Last Quarter		**23**	**"**	**8 P.M.**	**"**
New Moon	**Mar.**	**2**	**"**	**5 A.M.**	**"**

***Mercury* at the beginning of the month will be one hour west of the sun, although it will be nearly five degrees farther south and consequently will probably not be visible. On February 23 it will be on the opposite side of the sun from the earth.**

Venus will be more than an hour east of the sun and will cross the meridian later from day to day. It will be a brilliant object in the southwestern sky after sunset during this month.

Mars will be in the same part of the sky as Venus. They will both be rather near the sun, but Mars being fainter than Venus will not be so conspicuous. The sun will be overtaking Mars so that Mars will be lower in the sky every evening at sunset.



THE CONSTELLATIONS AT 9:00 P. M. FEBRUARY 1.

Jupiter having passed opposition in January will be in most favorable position for evening observations during this month. It will cross the meridian at nine o'clock in the evening on the average. It will be receding from the earth during this month.

Saturn too will be in a convenient position during this month. It will cross the meridian about midnight, the exact date of opposition being February 14.

Uranus will not be visible during this month. It will be in conjunction with the sun on February 16.

Neptune will be between Jupiter and Saturn in the sky. It is therefore favorably situated for observation during this month although it is visible only through the use of a telescope.

Phenomena of Jupiter's Satellites.

VISIBLE AT WASHINGTON.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME.

1919	h	m		
Feb. 2	10	20	II	Tr. I.
	11	53	II	Sh. I.
	13	02	II	Tr. E.
	13	28	I	Tr. I.
	14	13	I	Sh. I.
	14	36	II	Sh. E.
	15	42	I	Tr. E.
3	10	37	I	Oc. D.
	13	41	I	Ec. R.
4	5	07	II	Oc. D.
	5	51	III	Ec. R.
	7	54	I	Tr. I.
	8	41	I	Sh. I.
	9	23	II	Ec. R.
	10	09	I	Tr. E.
	10	56	I	Sh. E.
5	5	04	I	Oc. D.
	8	10	I	Ec. R.
6	5	25	I	Sh. E.
7	13	22	III	Tr. I.
9	12	42	II	Tr. I.
	14	30	II	Sh. I.
10	12	25	I	Oc. D.
11	6	05	III	Oc. R.
	6	36	III	Ec. D.
	7	27	II	Oc. D.
	9	42	I	Tr. I.
	9	53	III	Ec. R.
	10	36	I	Sh. I.
	11	56	I	Tr. E.
	11	58	II	Ec. R.
	12	51	I	Sh. E.
12	6	52	I	Oc. D.
	10	05	I	Ec. R.
13	6	23	I	Tr. E.
	6	34	II	Sh. E.
	7	19	I	Sh. E.
16	9	11	IV	Ec. D.

1919	h	m		
Feb. 16	11	58	IV	Ec. R.
17	14	13	I	Oc. D.
18	6	27	III	Oc. D.
	9	38	III	Oc. R.
	9	48	II	Oc. D.
	10	36	III	Ec. D.
	11	30	I	Tr. I.
	12	31	I	Sh. I.
	13	44	I	Tr. E.
	13	54	III	Ec. R.
	14	33	II	Ec. R.
19	8	41	I	Oc. D.
	12	00	I	Ec. R.
20	5	57	I	Tr. I.
	6	28	II	Sh. I.
	6	59	I	Sh. I.
	7	01	II	Tr. E.
	8	11	I	Tr. E.
	9	12	II	Sh. E.
	9	14	I	Sh. E.
21	6	30	I	Ec. R.
24	8	22	IV	Tr. I.
	10	44	IV	Tr. E.
25	10	05	III	Oc. D.
	12	13	II	Oc. D.
	13	16	III	Oc. R.
	13	19	I	Tr. I.
26	10	31	I	Oc. D.
	13	56	I	Ec. R.
27	6	47	II	Tr. I.
	7	47	I	Tr. I.
	8	54	I	Sh. I.
	9	06	II	Sh. I.
	9	29	II	Tr. E.
	10	01	I	Tr. E.
	11	09	I	Sh. E.
	11	50	II	Sh. E.
28	8	25	I	Ec. R.

Note:—I., denotes ingress; E., egress; D., disappearance; R., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

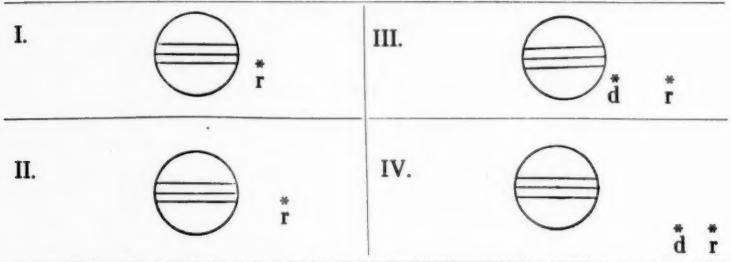
Satellites of Jupiter, 1919.

[From the *American Ephemeris.*]

GREENWICH MEAN TIME.

FEBRUARY

Phases of the Eclipses of the Satellites for an Inverting Telescope.



Configurations at 15h 45m for an Inverting Telescope.

Day	West	East
1	·3 ·1 ○ ·2 ·4	
2	·3 2○· 1· ·4	
3	·2·3 ·○1 ·4	
4	○1· ○ ·2·3 4·	
5	○ ·1 2· ·3 4·	
6	2· 1· ○ 4· 3·	
7	·2 ○ 4· 3· ·1	
8	3. 4· ·1 ○ .2	
9	4·.3 ○ 2·1·	
10	4· 2· 3 ·1○	
11	○1· 4· ○ ·2●·3●	
12	·4 ○ 2· ·3 ·1●	
13	·4 2· 1· ○ 3·	
14	·4 ·2 ○ 3· ·1	
15	3· 1· ·4 ○ ·2	
16	3· ○ 2· 1· ·4●	
17	3 2· ·1 ○ ·4	
18	.○ 1· 2 ·3 ·4	
19	○ 2· ·3 ·4 ·1●	
20	2· 1· ○ ·1 3· 4·	
21	·2 ○ ·1 3· 4·	
22	3· 1· ○ .2 4·	
23	3· ○ 1· 4·	
24	○4. ·3 2· ·1 ○	
25	4· ·2.○3 1·	
26	4· ·○1 ·2·3	
27	○1· 4· 2·○ 3·	
28	4· ·2 ○ ·1 3·	

Saturn's Satellites.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME.

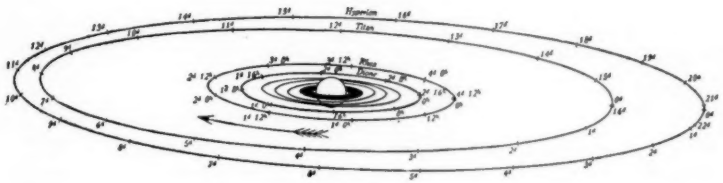
I. Mimas. Period 0^d $22^h.6$.

1919	h		h		h		h
Feb. 1	14.8 W	Feb. 8	16.4 E	Feb. 15	18.0 W	Feb. 23	6.9 W
2	13.4 W	9	15.0 E	16	16.6 W	23	18.2 E
3	12.0 W	10	13.6 E	17	15.2 W	24	5.5 W
4	10.6 W	11	12.2 E	18	13.8 W	24	16.8 E
5	9.2 W	12	10.8 E	19	12.4 W	25	15.4 E
6	7.8 W	13	9.4 E	20	11.0 W	26	14.0 E
6	19.1 E	14	8.0 E	21	9.6 W	27	12.6 E
7	6.4 W	14	19.3 W	22	8.2 W	28	11.2 E
7	17.7 E	15	6.6 E	22	19.6 E		

II. Enceladus. Period 1^d $8^h.9$.

Feb. 1	15.8 E	Feb. 8	12.2 E	Feb. 15	8.6 E	Feb. 22	5.0 E
3	0.7 E	9	21.1 E	16	17.5 E	23	13.8 E
4	9.6 E	11	6.0 E	18	2.3 E	24	22.7 E
5	18.5 E	12	14.8 E	19	11.2 E	26	7.6 E
7	3.3 E	13	23.7 E	20	20.1 E	27	16.5 E

South



North

SATELLITES OF SATURN, 1919

Apparent Orbits of the Seven Inner Satellites of Saturn at Date of Opposition, February 14, 1919, as seen in an inverting telescope.

III. Tethys. Period 1^d $21^h.3$.

Feb. 2	17.7 E	Feb. 10	6.9 E	Feb. 17	20.0 E	Feb. 25	9.2 E
4	15.0 E	12	4.2 E	19	17.3 E	27	6.5 E
6	12.3 E	14	1.4 E	21	14.6 E		
8	9.6 E	15	22.7 E	23	11.9 E		

IV. Dione. Period 2^d $17^h.7$.

Feb. 1	1.9 E	Feb. 9	6.9 E	Feb. 17	11.8 E	Feb. 25	16.8 E
3	19.6 E	12	0.5 E	20	5.5 E	28	10.4 E
6	13.2 E	14	18.2 E	22	23.1 E		

V. Rhea. Period 4^d $12^h.5$.

Feb. 2	0.6 E	Feb. 11	1.3 E	Feb. 20	1.9 E	Feb. 24	14.2 E
6	13.0 E	15	13.6 E				

VI. Titan. Period 15^d $23^h.3$.

Feb. 4	8.1 W	Feb. 12	12.5 E	Feb. 20	5.5 W	Feb. 28	10.0 E

VII. Hyperion. Period 21^d $7^h.6$.

Feb. 1	5.0 W	Feb. 11	16.6 E	Feb. 22	8.0 W

VIII. Iapetus. Period 79^d $22^h.1$.

Feb. 7	15.9 W	Feb. 27	8.3 S

IX. Phoebe. Period 523d 15h.6.

		α Ph.−α Sat.	δ Ph.−δ Sat.			α Ph.−α Sat.	δ Ph.−δ Sat.
		m s	′ ″			m s	′ ″
Feb.	2	−1 46.7	+11 40	Feb.	16	−1 58.9	+12 18
	4	48.6	47		18	2 00.5	22
	6	50.4	53		20	02.0	25
	8	52.2	11 58		22	03.5	28
	10	53.9	12 04		24	04.9	31
	12	55.6	08		26	06.3	34
	14	−1 57.3	+12 13		28	−2 07.6	+12 36

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1919		Star's Name	Magnitude	IMMERSION. Washington M.T.		Angle from N.	EMERSION. Washington M.T.		Angle from N.	Duration	
				h	m	°	h	m	°	h	m
Feb.	8	51 Tauri	5.6	7	24	84	8	46	266	1	23
	8	56 Tauri	5.2	8	20	45	9	19	309	1	00
	8	247 B Tauri	5.8	12	27	75	13	21	291	0	54
	9	108 Tauri	6.2	5	50	13	6	14	337	0	24
	9	*n* Tauri	5.1	7	34	81	8	57	282	1	23
	9	*o* Tauri	4.8	12	17	69	13	10	310	0	54
	10	15 Geminorum	6.5	12	47	71	13	40	320	0	53
	10	16 Geminorum	6.2	12	59	133	13	55	257	0	56
	12	29 Cancri	5.9	17	39	64	18	14	334	0	35
	14	14 Sextantis	6.3	16	52	93	17	49	318	0	57
	15	237 B Leonis	6.3	15	43	115	16	56	303	1	14
	15	55 Leonis	6.1	17	57	77	18	46	331	0	49
	21	147 B Librae	6.2	12	10	78	13	07	319	0	57

VARIABLE STARS.

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5h; Central standard time 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1919. February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7			17 17					
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	7 18;	15 22;	19 23;	24 1				
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	8 15;	16 9;	20 6;	24 3				
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2			15 17					
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	6 21;	14 19;	22 18;	26 17				
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	2 5;	10 0;	17 19;	25 14				
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	5 0;	12 7;	19 13;	26 20				
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0		11 0;		27 0				
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	4 0;	8 7;	16 21;	25 11				
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	3 0;	14 3;		25 7				
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0		11 2;	22 17					
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	3 9;	6 11;	14 2;	21 18				
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3		9 17;	19 20					
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	6 9;	14 2;	21 19;	25 16				
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	5 22;	11 11;	16 23;	22 12				
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	7 9;	14 22;	22 12					
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3		15 5						
RT Aurigae	23.0	+30 33	5.1— 6.0	3 17.5	7 14;	15 1;	22 12;	26 5				
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	6 22;	14 3;	21 8;	28 13				
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	7 17;	15 15;	23 13					
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	2 14;	12 17;	22 21					
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5		17 5						

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1919. February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	5 23;	13 22;	21 20;	25 20				
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	6 9;	13 2;	19 18;	26 11				
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	5 12;	10 3;	19 10;	28 17				
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	7 14;	11 23;	16 8;	25 2				
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 00.0			24 0					
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	7 4;	13 22;	20 17;	27 12				
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	5 9;	11 24;	18 14;	25 5				
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	1 21;	11 12;	21 5					
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	4 11;	12 11;	20 10;	28 10				
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	6 4;	12 22;	19 15;	26 8				
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	9 18;	15 13;	21 9;	27 5				
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	10 19;	15 11;	20 4;	24 21				
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5		10 2		27 9				
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	5 10;	13 15;	21 20					
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	6 17;	13 18;	20 18;	27 19				
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	4 6;	12 11;	20 17;	28 22				
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	7 8;	12 20;	18 8;	23 19				
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	3 11;	10 24;	18 13;	26 2				
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	4 22;	12 8;	19 18;	27 4				
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	6 20;	13 15;	20 10;	27 4				
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	7 19;	14 3;	20 10;	26 18				
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1	2 18;	12 12;	22 6					
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	6 3;	10 13;	14 23;	23 20				
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	7 14;	13 15;	19 17;	25 18				
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	6 17;	13 17;	20 17;	27 18				
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	7 1		24 4					
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	5 10;	13 1;	20 15;	28 5				
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	9 1;	14 19;	20 14;	26 8				
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	6 19;	13 13;	20 7;	27 1				
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	7 18;	18 3		28 11				
Y Lyrae	18 34 2	+43 52	11.3—12.3	0 12.1	7 16;	13 17;	19 17;	24 18				
RZ Lyrae	18 39.9	+32 42	9.9—11.2	0 12.3	6 10;	12 14;	18 17;	24 20				
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	9 12;	15 11;	21 10;	27 9				
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	3 12;	12 14;	21 16					
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	1 13;	8 14;	15 14;	22 15				
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	4 23;	11 23;	18 23;	25 23				
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	6 18;	14 17;	22 17					
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	3 1;	11 17;	19 10;	27 3				
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	6 10;	13 14;	20 19;	27 23				
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	1 12;	9 22;	18 7;	26 16				
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	4 19;	11 3;	17 10;	23 18				
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3		14 14						
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	7 23;	12 10;	16 20;	25 17				
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	6 10;	13 4;	19 21;	26 14				
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	3 11;	10 14;	16 21;	23 14				
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4		15 14						
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	8 4;	16 1;	23 21					
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	4 10;	11 7;	18 5;	25 2				
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	8 8;	13 5;	22 22;	27 19				
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	3 2;	11 17;	20 9;	24 17				
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	9 23;	15 8;	20 17;	26 2				
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1		10 13;	21 11					
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	6 13;	12 23;	19 10;	25 20				
V Lacertae	44.5	+55 48	8.5— 9.5	4 23.6	8 23;	13 22;	18 22;	23 22				
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.7	9 2;	14 13;	20 0;	25 11				
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	8 0;	13 11;	18 21;	24 8				
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	8 13;	14 20;	21 3;	27 10				
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	3 5;	15 9;	27 12					
V Cephei	23 51.7	+82 38	6.0—7.0	0 23.9	5 22;	8 22;	15 22;	22 21				

Minima of Variable Stars of Short Period.

[Calculated by D. C. Kazarinoff at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard 6^h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1919 February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8								
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	3 4;	10 20;	18 12;	26 5				
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	7 11;	14 22;	17 21;	22 8				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	2 13;	10 1;	17 12;	25 0				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	10 9;	16 11;	22 14;	28 17				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	7 12;	14 15;	21 19;	28 22				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	1 17;	8 13;	15 10;	22 7				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	7 19;	14 23;	18 13;	22 3				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	3 20;	12 14;	21 9;	24 7				
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	1 10;	9 8;	17 7;	25 6				
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6		12 23						
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	10 15;	16 9;	22 2;	28 20				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	4 3;	10 22;	17 17;	24 12				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	7 0;	14 21;	22 19;	26 18				
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	4 4;	12 11;	20 18;	23 13				
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	2 10;	10 7;	18 4;	26 2				
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	7 22		21 3					
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	5 7;	14 18;	17 22;	24 5				
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	6 17		19 3					
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	7 22;	14 14;	21 6;	27 22				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	2 21;	11 2;	19 6;	27 10				
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	6 8;	12 9;	18 9;	24 10				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	4 9;	13 1;	21 17;	26 1				
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	6 0;	11 5;	21 14;	26 19				
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	6 7;	14 7;	22 7;	26 8				
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	6 7;	12 1;	17 18;	23 12				
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	11 10;	17 0;	22 15;	28 5				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	7 12;	15 17;	23 21;	28 0				
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	6 0;	13 15;	21 6;	28 21				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	8 18		20 23					
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	5 20;	13 0;	20 4;	27 8				
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	4 7;	11 3;	17 22;	24 18				
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	5 23;	15 6;	24 13					
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	8 12;	15 3;	21 18;	28 8				
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	8 20;	17 5;	25 15;	28 10				
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	8 13;	15 0;	21 10;	27 20				
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	5 10;	12 17;	19 23;	27 6				
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	6 0;	14 3;	22 6;	24 7				
S Cancri	8 38.2	+19 24	8.2—10	9 11.6		9 12;	19 0;	28 11				
RX Hydrae	9 00.8	− 7 52	9.1—10.5	2 6.8	6 6;	13 2;	19 22;	26 19				
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	3 3;	14 23;	20 22;	26 20				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	3 3;	9 21;	16 15;	23 9				
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	7 13;	11 6;	14 23;	22 9				
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	6 12;	13 2;	19 17;	26 7				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	5 10;	14 5;	23 0					
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	1 23;	9 7;	16 15;	23 23				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	2 14;	9 9;	16 4;	22 23				
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	4 19;	12 7;	19 19;	27 7				
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	5 17;	10 12;	15 7;	24 21				
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	2 8;	9 19;	17 5;	24 16				
133926 Hydrae	13 39.0	−26 24	8.6—12.7	2 21.5	5 5;	11 0;	16 19;	32 14				
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	3 13;	10 12;	17 12;	24 12				

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1919 February							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	5 8;	12 6;	19 4;	26 1				
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.3	3 16;	6 12;	14 22;	23 8				
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	7 4;	14 20;	22 12;	26 8				
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	4 0;	11 8;	18 16;	26 0				
SX Ophiuchi	12.6	− 6 25	10.5—11.2	2 01.5	3 14;	11 21;	20 3;	28 9				
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	4 20;	9 6;	18 3;	26 23				
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	2 10;	13 21;	23 14					
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	1 20;	8 15;	15 10;	22 5				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	5 7;	13 17;	22 2;	27 3				
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	2 3;	8 7;	20 14;	26 18				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	5 7;	12 13;	19 18;	26 23				
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	1 14;	8 23;	16 8;	23 17				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	2 13;	6 16;	14 20;	23 0				
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	2 15;	10 4;	17 17;	25 6				
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	2 4;	9 22;	17 15;	25 9				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	4 5;	12 4;	20 4;	28 4				
WX Sagittae	53.6	−17 24	9.2—10.8	2 03.1	1 23;	10 12;	19 0;	27 13				
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	3 0;	12 8;	21 16;	26 8				
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	1 16;	12 0;	22 8;	27 12				
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	2 9;	9 15;	16 21;	24 3				
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	3 4;	10 2;	16 23;	23 21				
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2		10 0;	25 3					
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	4 22;	12 1;	19 5;	26 9				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	7 10;	14 13;	21 16;	28 18				
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	4 6;	12 13;	20 20;	25 0				
RR Draconis	40.8	+62 34	9.3—13	2 19.9	5 5;	13 17;	22 5;	25 1				
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	4 18;	11 9;	18 1;	24 16				
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	2 20;	15 18;	28 15					
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	6 12;	14 3;	21 18;	25 14				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	6 19;	14 9;	21 23;	25 18				
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	2 11;	9 16;	16 20;	24 1				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	4 5;	13 4;	22 3;	26 15				
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	1 17;	8 12;	15 6;	22 0				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	2 7;	9 16;	17 1;	24 9				
TT Lyrae	24.3	+41 30	9.4—11.6	5 05.8	8 9;	13 15;	18 20;	24 2				
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	5 20;	12 9;	18 21;	25 10				
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	6 14;	12 14;	18 14;	24 14				
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	4 9;	11 0;	17 15;	24 7				
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	4 0;	8 13;	17 17;	26 20				
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	6 23;	15 9;	23 19					
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	7 18;	14 13;	21 8;	28 2				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	5 7;	12 4;	19 2;	26 0				
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0		14 8						
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	4 23;	14 14;	19 10;	24 5				
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	1 15;	6 5;	15 10;	24 15				
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	5 6;	12 18;	20 6;	27 18				
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	1 1;	8 15;	16 5;	23 20				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	4 9;	9 10;	14 11;	24 13				
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	7 3;	14 13;	21 22;	24 21				
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	4 11;	9 0;	14 4;	23 20				
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	4 17;	8 15;	16 12;	24 9				
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	1 5;	11 9;	21 12;	26 14				
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3		14 13						
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	6 11;	11 15;	16 20;	22 0				
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.4	3 15;	11 22;	20 5;	28 12				
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.3	7 0;	14 12;	22 1;	25 19				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	2 20;	11 2;	19 7;	27 13				

COMET AND ASTEROID NOTES.

Wolf's Comet.—Wolf's comet is very faint now but may be observed with large telescopes. The following is an approximate ephemeris.

	α			δ		log r	log Δ
	h	m	s	°	′		
Dec. 30	23	37	34	−4	05	0.2019	0.1867
Jan. 3	23	48	46	3	59	.2032	.1963
7	23	59	51	3	50	.2047	.2063
11	0	10	49	3	38	.2066	.2161
15	0	21	36	−3	24	0.2087	0.2259

New Comet (Schorr).—A cablegram from Professor Elis Strömgren, of the Copenhagen Observatory, received at Harvard College Observatory on November 29, announced the discovery of a new comet by Professor Schorr, director of the Hamburg observatory, in the following position:

November 23.338 G.M.T. R.A. $4^h\ 12^m\ 08^s.9$, Dec. + 11° 35′ 23″.

The comet was of magnitude 14, and had a daily motion of 44^s west and 2′ south.

The comet was looked up at Northfield on the evening of December 6 and was found close to its predicted place. It was too faint for us to determine its exact position with the 16-inch telescope, not being visible at all at first, but being glimpsed after prolonged looking and averted vision. It was perhaps 30″ in diameter with no nucleus which could be distinguished. As it is apparently growing fainter, it will not be an object of interest to the amateur.

The following are all the observed positions which have come to hand:

Greenwich M. T.	α	δ	Observer	Place
November 23.338	$4^h\ 12^m\ 08^s.9$	+11°35′23″	Schorr	Bergedorf
25.3514	4 10 39.2	+11 38 30	Schorr	Bergedorf
29.8297	4 07 37.6	+11 47 47	Burton	Washington
30.6602	4 07 04.2	+11 49 47	Burton	Washington
30.7069	4 07 02.8	+11 49 49	Aitken	Mt. Hamilton
30.7466	4 06 59.5	+11 49 56	Barnard	Williams Bay

The following elements were computed by Jeffers, of the Students' Observatory, Berkeley, California, from observations on November 23, 29, and 30.

ELEMENTS OF SCHORR'S COMET.

Time of perihelion passage	T = 1918 Oct. 8.29 G. M. T.
Perihelion minus node	ω = 285° 16′
Longitude of node	Ω = 116 19
Inclination	i = 5 46
Perihelion distance	q = 1.926
Eccentricity	e = 0.4584
Periodic time	P = 6.71 years

The elements are uncertain and the orbit is probably elliptical.

The following ephemeris shows that the comet was moving slowly westward in Taurus, and that its course will carry it by January 1 about a degree north and west of the star λ Tauri. Its brightness is diminishing.

EPHEMERIS.

G. M. T.	α	δ	Light
1918 Dec. 4.5	$4^h\ 04^m\ 51^s$	+ 11° 58′	0.25
8.5	4 02 23	+ 12 12	
12.5	4 00 15	+ 12 28	
16.5	3 58 28	+ 12 45	0.21

GENERAL NOTES.

The war is over. Many of the astronomers, who have been temporarily engaged in war work problems, will be returning to their former work or to new fields of labor. We shall be glad to receive news items concerning these at any time.

Dr. C. C. Crump, who has been for a time with the Bureau of Standards, at Washington, D. C., has returned to his position as Professor of Astronomy at Ohio Wesleyan University, Delaware, Ohio.

Mathematical Association of America.—The fourth annual meeting of the Mathematical Association of America will be held at the University of Chicago on Friday, December 27, 1918, in conjunction with the American Mathematical Society which meets on Friday and Saturday. The first session will begin at ten o'clock on Friday morning in Room 32 of Ryerson Physical Laboratory, and all sessions will be held in this room. On Friday afternoon there will be a joint meeting of the two organizations and on Friday evening a joint dinner at the Quadrangle Club.

Prizes of the Paris Academy of Sciences.—The following prizes have been awarded by the Paris Academy of Sciences for work in mathematics and astronomy for the year 1918:

Poncelet prize (2000 francs) to Joseph Larmor, of Cambridge University, for the totality of his mathematical researches.

Francoeur prize (1000 francs) to P. Montel, of the University of Paris, for his investigation of series of analytic functions.

Lalande prize (540 francs) to A. Belopolsky, of the Pulkowa Observatory, for his contributions to the application of spectrum analysis to astronomy.

Valz prize (460) francs) to F. Sy, of the Algiers Observatory, for the totality of his works on astronomy.

Janssen prize (medal) to S. Chevalier, director of the Shanghai Observatory, for his researches in physical astronomy.

Eclipse of Saturn's Satellite Japetus.—The following cablegram from Professor Elis Strömgren of Copenhagen, published in Bulletin 672 of Harvard College Observatory, was received too late to be inserted in the December number of POPULAR ASTRONOMY.

"Bernewitz calculated eclipse Saturnian satellite Japetus December nine commences twentyone hours decimal eleven finishes twentythree decimal eightsix aberrationtime one decimal twentytwo eclipse important for determining Saturn's flattening."

The Eclipse of Japetus in the Shadows of the Ball and Ring System of Saturn.—The entire night of December 9 was cloudy at the Yerkes Observatory, and no observations were possible of the eclipse of Japetus, as announced by Professor Strömgren in H. C. O. Bulletin No. 672.

Such an eclipse is rare and it is to be hoped that other observatories were favored by better weather and that the satellite was favorably observed in Europe and America.

The eclipse of Japetus on November 1, 1889, was observed by the writer at the Lick Observatory. See *Monthly Notices* R. A. S. Vol. 50, p. 107, Jan. 1890, and *Astronomy and Astrophysics* Vol. 11, p. 119 (No. 102), 1892. That eclipse was the only one observed until the present time. E. E. BARNARD.

Y. O., 1918, December 12.

Inquiry in Regard to Measuring Machine.—We are in correspondence with the firm of Wm. Gaertner & Co., Chicago, re measuring machine similar to ones made for Yerkes, Schlesinger, Slocum, Mitchell, and Slipher. The cost of construction will be materially lessened if several machines were ordered, and I should be glad to learn of any Observatory or institution that contemplates securing such apparatus. Perhaps if you were to give this letter place in the next number of POPULAR ASTRONOMY, it might elicit information mutually beneficial. I shall be glad to hear from any one on the matter.

OTTO KLOTZ,
Chief Astronomer and Director.

Dominion Astronomical Observatory,
Ottawa, Canada, Dec. 13, 1918.

Observations of Nova Aquilae No. 3.—Professor Marcel Moye of Montpellier (Hèrault) France communicates in a private letter the following observations of Nova Aquilae. He expresses also his "hearty congratulations for the splendid success of the American Army."

		Mag.			Mag.
1918 Sept.	2	4.7	Oct.	7	4.9
	3	4.7		8	4.8
	6	4.2		9	5.0
	8	4.5		10	5.2
	9	4.7		24	5.4
	11	4.6		25	5.4
	24	5.1		26	5.5
	26	5.3		27	5.4
	27	5.2		28	5.5
	28	5.3		29	5.5
	29	5.3		30	5.5
Oct.	1	4.7		31	5.6
	2	4.8	Nov.	1	5.5
	3	4.8		5	5.6
	5	4.9		12	5.6

Comparison Stars from the Harvard Photometry:

	Mag.		Mag.
θ Serpentis	4.1	Fl. 4 Aquilæ	5.0
μ Aquilæ	4.7	Fl. 5 Aquilæ	5.7

Popular Ignorance of Astronomy.—In his address to the British Astronomical Association at the annual meeting October 30, 1918, the retiring president, Sir F. W. Dyson, Astronomer Royal of England, spoke chiefly of the need of education in astronomy in the public and secondary schools of England. The following is an extract from his address:

"In spite of the spread of general education, the knowledge of the elementary facts of Astronomy is probably less widely diffused than it used to be. Several causes have contributed to this. Life in towns is not conducive to observation of the stars. The view is restricted and the artificial illumination spoils what is left. We must all have noticed how much more visible the Milky Way has been near London since the lighting restrictions. Again, artificial illumination makes us

independent of the Moon. Owing to the air raids, a temporary revival of interest has taken place in the times of the Moon's rising and setting and in its phases. But, apart from this, many Londoners hardly know there is a Moon, and certainly are unfamiliar with its changes. In another way, too, we are independent of the Sun and stars, and so forget about them. The time can always be got from the nearest post office or railway station. In some way or other it is found at Greenwich, and nobody else need trouble themselves. A hundred years ago I think a good many country clergymen, for example, could have determined the time for the villages in which they lived, but I am afraid only a very small percentage could do so now. In a thickly-populated country, we do not often need the stars to give our bearings, though probably many of us have at times found them useful. So it happens that a very large percentage of people in this country do not know the pole star. I have frequently, in showing visitors over the Royal Observatory, pointed out a photograph of the Orion Nebula and asked whether they knew the constellation of Orion. The answer is generally in the negative. It is, of course, only a guess on my part, but I expect there is a much better practical acquaintance with the constellations among the uncivilized tribes of Asia and Africa than among the peoples who are in 'the foremost files of time'."

Twelve New Spectroscopic Binaries.—The new Dominion Astrophysical Observatory has already begun to yield valuable astronomical results from the spectrograms taken with the 72-inch reflecting telescope. Twelve new spectroscopic binaries have been discovered by Director Plaskett and Assistant Young. From the list published in the *Journal of the Royal Astronomical Society of Canada*, November 1918, we have rearranged the data in the following table:

No.	Boss' Number	Harvard Revised Photom.	α 1900		δ 1900		Type	Mag.	Observed Range of Velocity		Discoverer
			h	m	°	′			km	km	
1	4098	6004	6	02.9	+10	10	A	5.63	—13.4 to	—42.7	Y
2	4104	6013	16	04.2	+17	30	A	6.07	—16.3 to	—80.7	Y
3	4123	6036	16	07.1	+58	12	A	6.31	—26.9 to	+11.5	P
4	4602	6809	18	07.5	+79	59	B5	6.18	— 1.2 to	+23.3	P
5	4661	6903	18	20.9	+39	27	A2	5.04	—19.7 to	—45.1	Y
6	4669	6917	18	22.1	+29	46	A	5.71	—10.9 to	+39.4	Y
7	4706	6977	18	30.8	+18	07	A	5.73	—40.4 to	+16.8	P
8	4870	7258	19	03.1	+41	16	A	6.15	— 8.0 to	—36.7	Y
9	5236	7807	20	20.0	+37	10	A	5.68	—35.1 to	—56.2	P
10	.....	8136	21	12.2	+47	33	B5	6.32	—60.7 to	+ 2.0	P
11	5918	8731	22	52.7	+48	09	B3	5.20	—32.2 to	+ 7.1	P
12	.....	8803	23	03.0	+59	13	B2	6.28	—14.8 to	+81.8	P

The Solar Motion.—In the *Communications* from the Mount Wilson Solar Observatory to the National Academy of Sciences, No. 52, Mr. Gustaf Strömberg gives the results of a "Determination of the Solar Motion and the Stream Motion based on radial velocities and absolute magnitudes." He used the radial velocities of 1300 stars of the types F, G and K, about 700 of which have absolute magnitudes determined spectroscopically by Adams. For the remaining 600 stars mean parallaxes were computed by the formula

$$\log \pi = \log A + \log (\mu + c) + m \log \epsilon,$$

in which π is the mean parallax, μ the proper motion, m the apparent magnitude, and A, c, and ϵ constants determined by means of the spectroscopic parallaxes.

From all of the stars Strömberg finds the polar coördinates of the apex of the sun's motion to be

$$A = 270°.9 \pm 3°.3 \qquad D = +29°.2 \pm 3°.4.$$

The sun's velocity V_o comes out 21.48 ± 1.02 km, with the constant $K = +0.36 \pm 0.60$ km, while the average radial velocity θ of the stars used, regardless of sign and corrected for the sun's motion, is 17.7 km.

Grouping the stars with reference to absolute magnitude, he finds that the intrinsically fainter stars show a tendency to yield smaller values of declination of the sun's apex and that the average radial velocities are progressively larger as the stars are fainter. This latter variation is shown in the last column of the following table:

No. of Stars	Average Absolute Magnitude	Average Apparent Magnitude	A °	D °	V_o km	θ km
			F AND G TYPE STARS.			
211	0.31	4.68	251.4	+22.5	19.4	11.3
177	1.44	5.42	267.5	+36.3	16.6	14.6
167	2.76	5.27	272.1	+36.4	22.8	16.3
170	5.29	6.41	(279.6)	(+10.9)	(27.1)	(23.9)
725	2.32	5.40	268.3	+26.1	20.1	17.2
			K TYPE STARS.			
122	0.54	4.22	279.6	+33.8	24.0	13.7
245	1.41	4.86	268.1	+37.2	20.4	16.6
99	2.58	5.12	284.5	+20.1	26.0	18.6
79	7.07	7.41	(289.0)	(+26.5)	(22.1)	(26.2)
545	2.25	5.13	277.0	+32.5	2.22	18.5
			M TYPE GIANTS.			
135	1.5	4.98	264.2	+26.1	26.8	16.9

Variation of velocity with type of star is not large.

As to stream motion Strömberg finds that it is probably a local effect caused by a preferential motion of the stars in both directions around the center of the stellar system. The position of the axis of preferential motion agrees closely with that found by other investigators. The maximum radial motion is found in negative galactic latitude for all the groups of stars. This is because the sun is above the real galactic plane, the distance being about 20 parsecs, corresponding to a parallax of 0″.05. There is a minimum of average radial velocity in galactic longitude about 256°, which may indicate that the center of our sidereal system is in that direction, approximately toward the southern constellation Carina.

Betelgeuse (α Orionis).—If you have room in the January 1919 number of POPULAR ASTRONOMY could I get you to call the attention of variable star observers to Alpha Orionis (Betelgeuse), which at the present (Dec. 6-10, 1918) time is a little brighter than normal. From just a year ago up to the last of March, 1918, there was a slight but steady decline in the brightness of Betelgeuse. On March 26-27, 1918, it was only 0.1 of a magnitude brighter than Alpha Tauri. Since that time it has brightened up, and is now nearly 0.4 of a magnitude brighter than Alpha Tauri and equal to Rigel. It is difficult to compare Betelgeuse with Rigel on account of the great difference in color. It has always seemed strange to me that variable star observers have not given this naked eye variable more attention. It is fully as interesting an object as Omicron Ceti, Beta Persei, Beta Lyræ, or Delta Cephei. The period of Betelgeuse is unknown and is most irregular, while the periods of these four are pretty well known; also the amount of variation with the exception of that of o Ceti. FRANK E. SEAGRAVE.

Boston, Dec. 11, 1918.

The Binary Stars, by Robert Grant Aitken, astronomer at the Lick Observatory, University of California. Douglas C. McMurtrie, New York, pp. 315. Price $3.15.

This splendid book should be in the hands of every observer of double stars, and of every one interested in the study of the movements and the theory of the origin of the heavenly bodies. Dr. Aitken gives in convenient form just what on needs to know historically as to the development of the study of the binary stars, the best methods of observing them and of computing their orbits. He treats of not only the visual binaries but also of those of which our only knowledge comes through the use of the spectroscope or spectrograph, and gives the best methods of calculating their orbits from spectrographic data. A chapter on "The radial velocity of a star," written by Dr. J. H. Moore, gives quite fully the methods employed at the Lick Observatory in determining the velocities of the stars in the line of sight.

In later chapters the author discusses the eclipsing binary stars (variables), the known orbits of 112 visual and 137 spectroscopic binaries, some binary systems of special interest, and a statistical study of the visual double stars in the northern sky. The relation between the periods and eccentricities is made very definite, the eccentricity increasing from 0.047 for an average period of 2.75 days to 0.539 for an average period of 170 years. The spectroscopic binaries are scattered through all classes of spectral type, being most numerous in Class B, while there are no visual binaries of Class B. The masses of binaries are found to compare with the mass of the sun, being somewhat larger on the average. Except in the case of β Lyræ, the brighter component of a binary is found to have the greater mass, the ratio of the fainter to the brighter being on the average about three-fourths.

In the last chapter Dr. Aitken treats briefly the theories which have been offered to account for the origin of binary stars. His concluding sentence is: "Personally, I am inclined to prefer the classical theory of general stellar evolution and the fission theory of the origin of binary stars, *as a working hypothesis*, frankly admitting, however, that the observed facts offer difficulties and objections which no means at present available can remove."

The book is issued as one of the Semi-Centennial Publications of the University of California.

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, November-December, 1918.

The Annual Meeting of the Association was held at the Harvard College Observatory on the afternoon of November 23. The members were cordially welcomed by the Director, Professor E. C. Pickering, and the members of the staff. After a group photograph had been taken the business meeting was called to order by the President, Mr. David B. Pickering. Reports were made by various Committees.

Mr. Leon Campbell read a timely and interesting paper on the Nova Aquilae illustrated by charts showing the light curve to date.

The members were notified of the incorporation of the Association under the Laws of the State of Massachusetts. The Articles of the Association and the

Variable Star Observations, Nov.-Dec., 1918.

Oct. 0 = 2421867 Nov. 0 = 2421898 Dec. 0 = 2421928

001032
S Sculptoris
J.D. Est. Obs.
242
1870.6 10.5 δ
75.7 10.0

001046
X Androm.
1929.7 11.7 M

001620
T Ceti
1839.5 5.3 Lt
45.6 5.3
71.5 6.6

001755
T Cassiop.
1835.5 7.8 Lt
70.3 8.3 Pe
73.3 7.8 Lt
1904.8 8.4 M

001726
T Androm.
1839.4 11.5 Lt
73.4 9.8
74.3 9.7 Pe
1904.8 8.7 M

001838
R Androm.
1835.4 6.7 Lt
48.3 6.7
70.3 7.0 Pe
71.4 7.3 Lt
74.3 7.2 Pe
99.6 8.1 V
1904.6 8.5 Hu
04.8 8.0 M
05.6 8.5 Pt
06.6 8.4 B
23.5 8.8 V

001909
S Ceti
1839.5 9.6 Lt
74.3 11.8 Pe
1901.6 12.9 Me

*002438*a
T Sculptoris
1872.7 12.9 δ
75.7 12.8

*002438*b
RR Sculptoris
1872.7 12.7 δ
75.7 12.9

002546
T Phoenicis
1872.7 12.7 δ

002833
W Sculptoris
J.D. Est. Obs.
242
1872.7 13.1 δ

003179
Y Cephei
1835.5 9.6 Lt
99.6 11.1 Wh
1900.6 10.9 Hu

004047
U Cassiop.
1839.4 11.1 Lt
70.3 9.4 Pe
73.3 9.9 Lt
1900.5 9.1 Y
04.8 8.8 M
29.7 9.2

004435
V Androm.
1835.4 9.9 Lt
48.3 9.7
64.4 9.2
99.6 10.4 V
1904.6 10.0 Hu
04.8 10.7 M

004533
RR Androm.
1839.4 11.4 Lt

004958
W Cassiop.
1835.5 9.4 Lt
73.3 9.1
99.6 8.9 Hu
1904.8 8.8 M

010102
Z Ceti
1839.5 9.9 Lt
73.4 9.5
1903.6 10.8 Wh

010940
U Androm.
1904.8 9.9 M

011041
UZ Androm.
1900.8 11.8 M

011272
S Cassiop.
1835.5 9.2 Lt
1904.6 9.7 Pt
04.8 9.6 M
08.6 9.7 Wh

011712
U Piscium
J.D. Est. Obs.
242
1903.6 11.0 Pi
06.6 11.5 Me
25.6 11.2 Hu

012502
R Piscium
1835.5 9.4 Lt
70.5 8.7
78.3 9.1 Pe
1903.6 9.0 Pi
03.6 9.8 Y
03.6 10.0 Me

013238
RU Androm.
1910.6 11.4 B

013338
Y Androm.
1910.6 9.8 B

014958
X Cassiop.
1835.5 12.0 Lt
73.3 11.1
1903.6 10.9 Y
07.9 12.0 M

015354
U Persei
1835.4 8.5 Lt
99.6 9.2 Hu
1903.6 9.0 Pi
07.9 9.8 M
08.6 9.0 Wh

015912
S Arietis
1905.6 14.2 Me

021024
R Arietis
1835.4 10.1 Lt
45.4 9.8
52.4 9.2
64.4 8.9
74.3 8.5 Pe
1900.6 8.5 Pt
00.6 8.4 Hu
03.6 9.0 Pi
07.9 9.6 M
10.6 9.2 B

021143
W Androm.
1835.4 11.4 Lt
48.3 11.6
70.5 12.2
99.6 9.5 Hu

021258
T Persei
J.D. Est. Obs.
242
1906.6 8.9 Hu

021403
o Ceti
1835.5 3.9 Lt
39,5 4.0
40.5 3.9
43.5 3.9
45.6 3.8
47.4 4.0
62.6 3.9 δ
64.4 3.9 Lt
71.5 4.3
72.7 3.9 δ
74.3 3.9 Pe
75.4 4.1 Lt
78.3 3.9 Pe
94.2 4.6
95.3 4.6
96.3 4.6
99.7 4.5 Pi
99.7 3.6 Mu
1901.6 4.7 Me
03.6 4.3 Wh
03.7 3.5 Mu
04.6 3.9 Hu
20.7 5.5 Mu
22.7 6.0 M
27.7 5.6 Mu

021558
S Persei
1906.6 9.0 Hu

022000
R Ceti
1839.5 10.6 Lt
45.6 10.3
70.5 8.0
74.3 8.6 Pe
78.3 8.6
96.3 9.1
1904.6 9.6 Wh
04.6 10.0 Me

022150
RR Persei
1899.6 10.6 Y
1903.5 10.3 Pi

022813
U Ceti
1845.6 8.7 Lt
99.6 10.5 Y
1902.6 10.4 Wh

023133
R Trianguli
J.D. Est. Obs.
242
1835.5 10.7 Lt
64.4 11.0
70.5 10.7
1906.6 9.0 Wh
10.8 11.0 M

024217
T Arietis
1835.5 9.7 Lt

024356
W Persei
1870.3 9.8 Pe
74.3 6.6
1903.5 11.0 Pi
06.6 11.0 Hu
08.6 11.5 Wh
10.8 11.7 M

025751
T Horologii
1872.7 12.6 δ

030514
U Arietis
1899.6 14.5 Me

031401
X Ceti
1839.5 9.5 Lt
45.6 9.2
70.5 8.7
1901.6 9.1 Me

032043
Y Persei
1874.3 10.2 Pe
1903.5 9.0 Pi
06.6 9.3 Hu
10.8 9.6 M
24.5 8.9 Pt

032335
R Persei
1835.5 8.8 Lt
64.4 9.3
1906.6 12.7 B
10.8 12.2 M
25.6 11.9 Hu

033362
U Camelop.
1835.5 7.4 Lt
71.4 7.4
1908.6 7.7 Wh
10.8 8.2 M

034124
S Fornacis
1872.7 8.9 δ

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1918—Continued

034625
U Eridani
J.D. Est. Obs.
242
1872.7 14.0± δ

035124
T Eridani
1872.7 9.0 δ

040725
W Eridani
1872.7 10.9 δ

041619
T Tauri
1907.9 9.5 M

042215
W Tauri
1899.6 11.8 Y
99.6 11.0 Wh
1903.6 11.6 Pi
07.9 10.9 M
09.6 10.6 B
23.6 10.6 V
29.6 10.6 M

042009
R Tauri
1871.5 12.0 Lt
1929.6 13.0 M

042309
S Tauri
1906.6 10.9 Hu
29.6 14.4 M

043065
T Camelop.
1835.5 10.2 Lt
73.3 12.3
1910.9 11.8 M

043263
R Reticuli
1872.7 11.6 δ

043208
RX Tauri
1903.6 11.9 Pi
07.9 12.0 M
09.6 12.1 B

043274
X Camelop.
1835.5 9.6 Lt
54.3 11.2
71.4 13.0
99.6 11.3 Y
99.6 11.1 Wh
1906.6 10.6 Hu
10.9 11.2 M
12.6 10.3 B
34.6 10.1 Y

043562
R Doradus
J.D. Est. Obs
242
1862.6 5.1 δ
72.7 5.5

043738
R Caeli
1872.7 9.2 δ

044349
R Pictoris
1872.7 7.3 δ

044617
V Tauri
1845.6 10.6 Lt
1903.6 10.3 Pi
07.9 10.7 M
09.6 10.5 B

045307
R Orionis
1907.9 12.5 M
24.6 13.2 Y

045514
R Leporis
1910.9 8.0 M
24.7 8.8 Pt

005022
T Leporis
1907.9 10 5 M

050003
V Orionis
1899.6 12.0 Y
1907.9 11.6 M
24.6 10.6 Y
25.6 10.8 Wh

050953
R Aurigae
1835 5 10.9 Lt
64.4 10.5
1910.9 10.1 M
23.6 10.1 V

051247
T Pictoris
1872.7 8.8 δ

051533
T Columbae
1872.8 7.3 δ

052034
S Aurigae
1910.9 10.2 M
12.6 9.1 B

052036
W Aurigae
1912.6 12.6 B

052404
S Orionis
J.D. Est. Obs.
242
1871.5 13.1 Lt
1903.7 10.3 Pi
27.8 12.4 M

053068
S Camelop.
1835.5 8.8 Lt
71.4 9.8
1927.8 10.3 M

*053005*a
T Orionis
1927.8 10.5 M

053327
RR Tauri
1912.6 11.4 B
27.8 11.2 M

053531
U Aurigae
1899.6 11.2 Y
1910.9 8.6 M
12.6 9.8 B
23.6 9.4 V
24.6 9.4 Y

053920
Y Tauri
1845.6 8.4 Lt

054319
SU Tauri
1845.6 9.8 Lt
99.7 9.3 Wh
1903.7 9.4 Pi
09.6 9.5 B
10.9 9.0 M
24.6 9.4 Y
27.7 9.4 V
27.7 9.4 Wh

054920
U Orionis
1845.6 8.1 Lt
71.6 9.0
1903.7 9.1 Pi
10.9 9.5 M
25.6 9.2 Hu

054974
V Camelop.
1903.6 9.8 Y
08.6 9.6 Wh
09.6 9.5 B
10.9 9.9 M
25.6 10.9 Wh

055353
Z Aurigae
1835.5 10.1 Lt
1910.9 11.0 M

055686
R Octantis
J.D. Est. Obs.
242
1843.5 11.5 δ
72.6 11.6

060450
X Aurigae
1845.6 12.7 Lt
71.5 12.7

060547
SS Aurigae
1903.7 < 12.4 Pi
24.6 11.0 Y
25.7 11.2 Pi
27.7 11.9 Wh
27.9 < 12.4 M
29.6 14.2 M

061647
V Aurigae
1912.6 8.8 B

061702
V Monoc.
1872.7 7.4 δ

063159
U Lyncis
1924.6 12.9 Y

063558
S Lyncis
1909.7 13.8 B

064030
X Gemin.
1845.6 9.6 Lt
71.5 8.3
1911.8 9.9 M

064707
W Monoc.
1872.7 10.5 δ
1911.8 10.4 M

065111
Y Monoc.
1909.6 13.0± Y

065208
X Monoc.
1872.7 8.1 δ
1911.8 7.8 M

065355
R Lyncis
1845.6 12.8 Lt
71.5 13.2
1912.7 12.5 B

070109
V Can. Min.
1924.8 9.8 M
25.7 9.7 Pi

070122a
R Gemin.
J.D. Est. Obs.
242
1870.5 8.1 Lt
1924.8 7.6 M
25.7 7.7 Pi

070122c
TW Gemin.
1924.8 8.2 M

070310
R Can. Min.
1925.7 10.7 Pi

071713
V Gemin.
1871.5 9.6 Lt

072106
Nova Monoc.
1872.7 11.5 δ

072708
S Can. Min.
1871.5 7.1 Lt
1900.8 7.9 M
11.8 8.3
25.7 9.0 Pi

073508
U Can. Min.
1911.8 12.6 M

073723
S Gemin.
1871.5 9.9 Lt
1904.8 8.8 M
25.7 9.5 Pi
27.7 9.9 V

074323
T Gemin.
1871.5 12.9 Lt
1911.8 9.1 M
25.7 9.0 Pi
27.7 8.7 V

074922
U Gemin.
1871.5 13.9 Lt
1903.7 < 10.9 Pi
25.7 < 12.3
27.7 < 11.4 V
29.6 14.4 M

080322
RU Puppis
1872.8 7.6 δ

081617
V Cancri
1924.8 9.6 M

082405
RT Hydrae
1872.8 8.1 δ

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1918—Continued.

083409
RV Hydrae
J.D. Est. Obs.
242
1872.8 8.7 δ

084803
S Hydrae
1911.8 9.0 M
25.8 9.7 Pt

085008
T Hydrae
1927.8 9.7 M

085120
T Cancri
1927.8 9.3 M

090151
V Urs. Maj.
1924.8 10.0 M

090425
W Cancri
1924.9 10.4 M
27.7 10.7 V

091868
RW Carinae
1843.5 12.5 δ
72.6 13.0±

092962
R Carinae
1843.5 8.5 δ
72.8 7.6

093014
X Hydrae
1924.9 11.6 M

093178
Y Draconis
1924.6 13.0 Y

093934
R Leo. Min.
1871.5 12.2 Lt
1927.8 10.7 M

094262
Z Carinae
1872.7 3.8 δ

094211
R Leonis
1911.8 10.2 M

094622
Y Hydrae
1927.8 6.7 M
28.8 7.5 Pt

095421
V Leonis
1927.8 9.0 M

100661
S Carinae
J.D. Est. Obs.
242
1843.5 8.4 δ
58.5 7.7
72.8 7.0

103769
R Urs. Maj.
1838.4 9.9 Lt
70.4 11.6
1911.8 12.7 M

104620
V Hydrae
1928.6 7.6 Pt

104814
W Leonis
1927.9 9.6 M

122532
T Can. Ven.
1907.9 9.9 M

123160
T Urs. Maj.
1838.4 10.0 Lt
70.4 12.8
74.3 11.9 Pe
74.4 11.0 Li
1907.9 12.1 M
24.6 12.4 Y

123459
RS Urs. Maj.
1874.3 8.6 Pe
1907.9 9.8 M

123961
S Urs. Maj.
1835.4 10.0 Lt
70.4 10.9
74.3 11.3 Pe
74.4 10.5 Li
1907.9 10.8 M
24.6 10.0 Y

124045
Y Can. Ven.
1838.4 5.8 Lt

131283
U Octantis
1872.6 8.7±δ

131526
V Can. Ven.
1835.4 7.3 Lt
73.3 6.5

133633
T Centauri
1843.5 7.2 δ
58.5 6.8
70.5 6.1

134236
RT Centauri
J.D. Est. Obs.
242
1843.5 12.9 δ
58.5 12.0

134440
R Can. Ven.
1835.4 8.2 Lt
73.3 8.0

134677
T Apodis
1843.5 11.4±δ
58.5 12.8

140528
RU Hydrae
1858.5 9.3 δ

140959
R Centauri
1820.6 7.1 δ
43.5 6.5
54.5 6.1
69.5 6.2
74.5 6.4

141567
U Urs. Min.
1835.5 7.7 Lt
71.4 8.2
1908.6 9.5 Wh

141954
S Bootis
1835.4 10.1 Lt
70.4 8.4
1908.6 8.8 Wh

142584
R Camelop.
1835.4 8,3 Lt
64.4 8.7
1908.6 10.7 Wh
10.6 10.4 B

142539
V Bootis
1835.4 7.5 Lt
43.4 7.2 Li
47.5 7.2
49.3 7.8 Lt
64.5 7.3 Li
73.3 7.9 Lt

143227
R Bootis
1835.4 12.2 Lt
43.4 11.6 Li
47.4 11.6
48.3 12.0 Lt
65.4 11.5 Li
70.4 11.1 Lt
1928.8 6.9 Pt

145254
Y Lupi
J.D. Est. Obs.
242
1843.5 9.1 δ
58.5 10.0
74.5 10.4

151714
S Serpentis
1838.4 8.5 Lt
70.3 10.1

151731
S Coronae
1839.3 12.9 Lt
43.4 12.4 Li
70.4 12.2 Lt
1924.5 9.2 Y

152849
R Normae
1843.5 8.9 δ
58.5 9.0
72.5 9.4
74.5 9.3

153378
S Urs. Min.
1835.5 11.1 Lt
71.4 9.9

153654
T Normae
1843.5 9.2 δ
58.5 10.2
72.5 11.3
74.5 11.5

154428
R Coronae
1835.4 7.0 Lt
39.3 7.1
45.3 7.1
48.3 7.0
49.3 7.0
70.3 6.7 Pe
70.4 7.0 Lt
88.2 6.7 Pe
94.2 6.6
1900.6 5.8 Pt
03.6 5.9
04.6 5.9
07.6 6.2 Wh
08.5 5.8 Pt
10.5 6.0
11.5 6.0
12.5 6.0
22.5 5.8
24.5 6.0
24.5 6.9 Y
27.5 6.0 Pt
28.5 6.0

154536
X Cor. Bor.
J.D. Est. Obs.
242
1839.4 12.0 Lt
70.4 13.3

154639
V Cor. Bor.
1839.3 10.2 Lt

154615
R Serpentis
1838.4 12.4 Lt
70.3 13.3

154736
R Lupi
1843.5 13.2 δ
58.5 13.5
74.5 13.2

160210
U Serpentis
1838.4 9.7 Lt
70.3 8.6

160325
SX Herculis
1820.4 8.6 Lt
38.4 8.7

161138
W Coronae
1839.3 10.5 Lt

162119
U Herculis
1838.4 7.6 Lt
47.4 7.3 Li
70.4 7.6 Lt
74.3 7.6 Pe
1903.6 8.1 Pt

162542
g Herculis
1821.4 5.2 Lt
27.4 5.2
35.4 5.0 Lt
38.4 5.0
45.4 4.9
47.4 5.0
48.3 5.0
52.4 5.1
54.3 5.2
73.4 5.2

162807
SS Herculis
1835.4 10.6 Lt
70.4 12.2

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1918—Continued.

163137
W Herculis

J.D. 242	Est.	Obs.
1835.4	9.3	Lt
45.4	10.8	Li
1924.5	13.5	Y

163172
R Urs. Min.

J.D. 242	Est.	Obs.
1835.5	9.5	Lt
1910.6	9.2	B

163266
R Draconis

J.D. 242	Est.	Obs.
1839.4	12.7	Lt
64.4	11.7	
71.4	11.4	
1908.6	8.4	Wh
10.6	8.2	B
21.5	7.8	Pt
24.5	7.8	Y

164055
S Draconis

J.D. 242	Est.	Obs.
1904.6	9.8	Pt

164715
S Herculis

J.D. 242	Est.	Obs.
1835.5	8.9	Lt
44.4	8.0	Li
64.3	8.5	Lt
1904.6	8.8	Pt

164844
RS Scorpii

J.D. 242	Est.	Obs.
1843.5	11.8	δ
58.5	11.9	
74.5	12.5	

165030
RR Scorpii

J.D. 242	Est.	Obs.
1843.6	10.8	δ
54.5	10.5	
58.5	10.5	
69.5	10.5	
74.5	10.4	

171401
Z Ophiuchi

J.D. 242	Est.	Obs.
1835.4	11.7	Lt
70.4	11.7	

171723
RS Herculis

J.D. 242	Est.	Obs.
1835.4	8.8	Lt
70.4	7.8	
74.3	8.2	Pe

172486
S Octantis

J.D. 242	Est.	Obs.
1872.6	9.6	δ

173457
TY Draconis

J.D. 242	Est.	Obs.
1870.3	9.3	Pe
78.3	9.3	
96.3	9.4	

175458
T Draconis

J.D. 242	Est.	Obs.
1924.5	7.8	Y

175458
UY Draconis

J.D. 242	Est.	Obs.
1924.5	11.2	Y

175519
RY Herculis

J.D. 242	Est.	Obs.
1839.4	13.3	Lt

180363
R Pavonis

J.D. 242	Est.	Obs.
1875.7	13.2	δ

180531
T Herculis

J.D. 242	Est.	Obs.
1835.4	11.3	Lt
64.4	9.1	
74.3	9.2	Pe
78.3	8.8	
96.3	8.8	
1903.6	9.2	Hu
08.6	9.3	Wh

180565
W Draconis

J.D. 242	Est.	Obs.
1908.6	9.2	Wh
10.6	9.1	B

180931
TV Herculis

J.D. 242	Est.	Obs.
1874.3	11.4	Pe

181136
W Lyrae

J.D. 242	Est.	Obs.
1835.4	9.6	Lt
44.4	8.8	Li
49.3	9.3	Lt
64.4	8.6	
65.4	8.5	Li
68.4	8.3	
71.4	8.2	
74.3	8.2	Pe
1903.6	8.3	Hu
08.6	8.2	Wh
09.6	7.9	B
21.5	9.1	Pt
24.5	8.7	Y

181103
RY Ophiuchi

J.D. 242	Est.	Obs.
1839.4	12.4	Lt
73.3	8.3	

182133
RV Sagittarii

J.D. 242	Est.	Obs.
1862.6	12.5	δ
70.5	13.5	

182224
SV Herculis

J.D. 242	Est.	Obs.
1835.4	13.0	Lt

183146
SV Draconis

J.D. 242	Est.	Obs.
1924.5	12.5?	Y

183225
RZ Herculis

J.D. 242	Est.	Obs.
1839.4	11.7	Lt
71.5	12.1	

183308
X Ophiuchi

J.D. 242	Est.	Obs.
1835.4	7.5	Lt
73.3	8.1	

184134
RY Lyrae

J.D. 242	Est.	Obs.
1903.6	11.0	Hu
08.6	11.4	Wh

184205
R Scuti

J.D. 242	Est.	Obs.
1821.4	6.0	Lt
22.4	6.0	
24.4	5.9	
27.4	5.8	
28.3	5.8	
30.5	5.9	
31.4	5.9	
33.4	5.8	
34.4	5.8	
35.4	5.7	
38.4	5.7	
39.3	5.6	
43.6	5.1	δ
45.3	5.5	Lt
47.4	5.3	
48.3	5.3	
49.3	5.4	
52.4	5.3	
54.3	5.5	
57.4	5.5	
62.6	5.4	δ
69.5	5.4	
70.3	5.8	Lt
70.3	5.6	Pe
71.4	5.9	Lt
72.5	5.7	δ
73.4	5.9	Lt
74.5	5.7	δ
77.3	5.9	Lt
78.3	5.8	Pe
88.2	5.6	
94.2	5.7	
96.3	5.7	
98.5	5.8	Re
1900.6	5.7	Pt
01.6	5.4	Mu
03.6	5.6	Pt

R Scuti

J.D. 242	Est.	Obs.
1903.6	5.3	Hu
03.7	5.4	Mu
04.6	5.2	Pt
08.5	5.3	.
08.6	5.3	Hu
10.5	6.0	Pt
12.5	5.5	
20.6	5.9	Mu
21.5	6.0	Pt
22.5	5.8	
24.5	5.7	
24.5	5.9	Re
25.5	5.8	Pt
27.5	5.8	
28.5	5.9	

184300
Nova Aquilae

J.D. 242	Est.	Obs.
1824.4	4.4	Lt
25.4	4.5	
26.4	4.4	
27.4	4.7	
28.3	4.8	
30.4	4.9	
31.4	4.9	
33.3	4.9	
33.6	4.3	δ
34.4	4.7	Lt
35.4	4.7	
36.4	4.7	
38.3	5.1	
39.3	5.2	
40.5	5.2	
42.4	4.7	
42.5	4.8	δ
43.4	4.6	Lt
43.6	4.4	δ
44.4	4.6	Li
45.3	5.0	Lt
46.3	5.1	
47.4	5.2	
47.5	4.8	Li
48.3	5.2	Lt
49.3	5.3	
49.4	4.8	Li
50.3	5.1	Lt
52.3	5.3	
53.4	5.2	
54.3	5.3	
57.4	5.0	
58.4	5.0	
60.4	5.0	
61.3	5.0	
62.3	5.0	Lt
62.6	5.2	δ
64.4	5.2	Lt
65.3	5.1	
68.4	5.0	
69.5	5.1	δ

Nova Aquilae

J.D. 242	Est.	Obs.
1870.3	5.0	Lt
70.3	5.1	Pe
71.4	5.1	Lt
73.3	4.9	
73.3	4.9	Li
74.5	5.3	δ
75.4	5.0	Lt
77.3	5.5	
78.3	4.8	Pe
88.2	5.1	
94.2	5.2	
96.3	5.3	
98.5	5.3	Re
99.5	5.6	V
1900.6	5.3	Pt
01.5	5.2	J
01.6	5.4	Mu
03.5	5.0	Pi
03.6	5.5	Wh
03.6	5.4	Pt
03.7	5.5	Mu
04.5	5.8	V
04.5	5.2	J
04.5	5.4	Re
04.6	5.4	Pt
08.5	5.5	Re
08.5	5.4	Pt
08.6	5.6	Wh
09.5	5.2	J
11.5	5.3	Pt
12.5	5.3	
20.6	5.6	Mu
21.5	5.2	J
22.5	5.5	Pt
22.6	5.5	Wh
23.5	5.7	V
24.5	5.6	Re
24.5	5.3	Pt
25.5	5.3	
27.5	5.7	V
27.5	5.2	Pt
28.5	5.3	J
28.5	5.4	Pt
28.5	5.6	Re

185243
R Lyrae

J.D. 242	Est.	Obs.
1827.4	4.3	Lt
33.4	4.2	
35.4	4.3	
38.4	4.2	
45.4	4.2	
47.4	4.2	
73.4	4.2	
1901.6	4.6	Mu
03.7	4.7	
20.6	4.5	

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1918—Continued.

190108
R Aquilae
J.D. Est.Obs.
242
1835.5 10.5 Lt
64.4 10.8

190967
U Draconis
1900.6 12.3 Hu

190925
S Lyrae
1912.6 11.5 B

191033
RY Sagittarii
1843.6 7.0 δ
54.5 6.8
62.6 6.8
69.5 6.6
72.5 7.0
75.7 6.9

191019
R Sagittarii
1903.6 7.2 Pt

191133
— Sagittarii
1843.5 9.4 δ
54.4 9.4
58.5 9.4
62.6 9.2
69.4 9.3
70.4 9.4

191124
TY Sagittarii
1870.5 10.4 δ

191350
TZ Cygni
1924.6 10.3 Y

192745
AF Cygni
1835.4 7.5 Lt
47.4 7.1
71.4 6.8

193449
R Cygni
1835.4 11.3 Lt
45.4 9.9
64.4 8.2
78.3 7.2 Re
1901.6 6.6 Me
03.6 6.6 Hu
06.6 6.9 B
21.5 7.3 Pt
22.5 6.8 V
22.6 7.5 M

193732
TT Cygni
1903.6 8.0 Hu
21.6 8.2 Pt

193972
T Pavonis
J.D. Est.Obs.
242
1870.5 8.5 δ

194048
RT Cygni
1835.4 11.4 Lt
64.4 11.6
99.6 10.0 Hu
1921.6 8.8 Pt
22.5 9.0 V

194348
TU Cygni
1899.6 11.4 Hu
1922.5 9.9 V

194659
S Pavonis
1870.5 6.9 δ

194604
X Aquilae
1839.4 12.6 Lt
71.5 12.6

194632
χ Cygni
1835.5 11.3 Lt
45.4 11.7
62.3 12.0

194929
RR Sagittarii
1870.5 11.0 δ

195116
S Sagittae
1901.6 5.2 Mu
03.7 5.8
20.6 6.0
27.7 5.7

195849
Z Cygni
1835.5 12.7 Lt
70.5 10.2
78.3 9.1 Pe
1901.6 9.3 Me
10.5 8.4 B
22.6 8.7 V
22.6 9.0 M

200357
S Cygni
1835.5 10.8 Lt
70.4 11.6

200514
R Capricorni
1839.4 11.7 Lt

200647
SV Cygni
1903.6 8.2 Hu
08.7 9.0 Pi
22.6 9.1 M

200715a
S Aquilae
J.D. Est.Obs.
242
1835.5 9.6 Lt
71.5 10.3
1901.5 9.6 Me

200715b
RW Aquilae
1901.5 9.2 Me

200916
R Sagittae
1835.5 9.1 Lt
71.5 8.8
1901.5 8.2 Me

200906
Z Aquilae
1835.5 10.9 Lt
49.3 9.9
71.5 9.7

200938
RS Cygni
1927.6 8.9 Pt

201008
R Delphini
1835.5 9.0 Lt
65.4 10.2 Li
71.5 10.4 Lt

201139
RT Sagittarii
1870.6 7.3 δ

201121
RT Capricorni
1924.6 7.5 Pt

201130
SX Cygni
1839.4 11.1 Lt
1903.6 9.0 Hu
12.6 9.2 B
24.6 9.8 Y

201647
U Cygni
1835.4 7.3 Lt
44.5 7.2 Li
70.5 7.5 Lt
71.4 7.8 Li
78.3 8.6 Pe
1908.7 8.4 Pi
22.6 9.2 M
24.6 8.8 Pt

202240
U Microscopii
1870.6 10.3 δ

202539
RW Cygni
1899.6 8.6 Wh

202946
SZ Cygni
J.D. Est.Obs.
242
1903.6 9.6 Hu
24.6 9.5 Pt

202954
ST Cygni
1835.5 10.8 Lt
1903.6 11.5 Hu
10.6 13.0 B

203226
V Vulpeculae
1921.6 9.0 Pt

203816
S Delphini
1835.5 10.7 Lt
1922.6 10.9 V

203847
V Cygni
1835.5 11.8 Lt
71.4 13.1

204318
V Delphini
1899.6 10.2 Hu
1908.6 10.5 Wh

204405
T Aquarii
1835.5 11.1 Lt
71.5 12.8
99.6 11.6 Me
1903.6 11.2 Hu
08.6 10.9

205030a
UX Cygni
1835.4 12.3 Lt

205017
X Delphini
1908.6 11.0 Wh

205627
RR Capricorni
1870.6 9.5 δ
75.6 9.1 δ

205923
R Vulpeculae
1835.5 9.6 Lt
68.4 10.3 Li
71.4 12.6 Lt
1904.6 9.8 Hu
08.6 9.4 Wh
27.6 8.9 Pt

210116
RS Capricorni
1924.6 8.1 Pt

210382
X Cephei
J.D. Est.Obs.
242
1903.6 11.0 Y

210868
T Cephei
1835.5 9.5 Lt
71.5 8.4
1900.6 6.6 Hu
03.6 7.5 Pt

210812
R Equulei
1835.5 9.7 Lt
71.5 10.9

211614
X Pegasi
1904.6 11.6 Me
24.6 11.2 Y

212030
S Microscopii
1870.6 10.8 δ

213244
W Cygni
1822.4 6.5 Lt
24.4 6.5
33.4 6.3
39.3 6.1
45.4 6.1
52.4 6.1
54.3 5.9
73.4 6.0

213678
S Cephei
1839.4 11.3 Lt
71.5 10.0
1900.6 8.6 Hu
27.6 9.7 Pt

213753
RU Cygni
1908.7 9.6 Pi

213843
SS Cygni
1821.4 11.8 Lt
22.4 11.8
31.4 11.8
35.4 11.9
38.4 11.9
39.4 11.8
45.4 8.5
46.3 8.9
47.4 9.2
48.3 9.5
49.3 9.7
50.3 9.5
52.4 10.8
54.3 11.5

VARIABLE STAR OBSERVATIONS, Nov.-Dec., 1918—Continued.

SS Cygni

J.D. 242	Est.	Obs.
1858.4	11.8	
62.3	11.8	
64.4	11.8	
70.5	11.8	
71.4	11.8	
75.4	11.8	
99.6	10.7	Me
99.7	11.5	Pi
1900.6	8.5	Pi
00.6	8.9	Hu
03.5	8.2	Pi
03.6	8.2	Pt
03.6	8.4	Hu
04.6	8.4	
04.6	8.7	Wh
04.6	8.5	Y
04.6	8.2	Pt
06.6	8.5	Hu
08.5	8.3	Pt
08.6	8.8	Hu
08.6	8.7	Wh
08.7	8.5	Pi
09.6	8.7	B
09.6	8.9	Y
10.6	8.9	B
11.5	8.8	Pt
12.6	9.2	B
21.6	11.6	Wh
22.5	12.0	M
22.6	<11.3	V
24.6	11.6	Y
25.6	11.7	Hu

213937
RV Cygni

J.D. 242	Est.	Obs.
1903.6	7.5	Hu
08.7	8.3	Pi
21.6	8.3	Pt

214247
R Gruis

J.D. 242	Est.	Obs.
1870.6	14.0	δ
75.6	14.2	

215605
V Pegasi

J.D. 242	Est.	Obs.
1839.4	8.9	Lt
1900.6	11.2	Me

220133a
RY Pegasi

J.D. 242	Est.	Obs.
1839.4	12.3	Lt

220133b
RZ Pegasi

J.D. 242	Est.	Obs.
1839.4	11.9	Lt

220412
T Pegasi

J.D. 242	Est.	Obs.
1905.6	13.0	Me

221948
S Gruis

J.D. 242	Est.	Obs.
1870.6	11.3	δ
75.6	11.3	

222439
S Lacertae

J.D. 242	Est.	Obs.
1839.4	12.8	Lt
71.4	11.7	

223462
T Tucanae

J.D. 242	Est.	Obs.
1870.6	8.0	δ
75.6	8.1	

225120
S Aquarii

J.D. 242	Est.	Obs.
1899.6	10.5	Me
1903.6	10.1	Pi
08.6	8.9	Hu
24.6	8.9	Y

225914
RW Pegasi

J.D. 242	Est.	Obs.
1900.6	10.8	Me
12.6	10.3	B
22.6	10.4	V
24.6	10.2	Y

230110
R Pegasi

J.D. 242	Est.	Obs.
1839.4	13.0	Lt
70.5	13.2	
96.3	12.4	Pe
1904.6	10.0	Hu
06.6	12.5	Me
24.6	12.1	Y

230759
V Cassiop.

J.D. 242	Est.	Obs.
1839.4	12.7	Lt
73.3	11.2	
1906.5	9.5	B
21.6	8.3	Pt
22.6	8.9	V

231425
W Pegasi

J.D. 242	Est.	Obs.
1904.6	12.1	Me

231508
S Pegasi

J.D. 242	Est.	Obs.
1870.3	12.0	Pe
74.3	12.0	
96.3	10.8	
1901.6	10.8	Me

232746
V Phoenicis

J.D. 242	Est.	Obs.
1870.7	13.0	δ
75.6	13.2	

233335
ST Androm.

J.D. 242	Est.	Obs.
1904.6	11.6	Hu

233451
SV Cassiop.

J.D. 242	Est.	Obs.
1839.4	8.7	Lt
73.3	9.0	

233815
R Aquarii

J.D. 242	Est.	Obs.
1839.5	9.6	Lt
73.4	9.2	
95.3	6.6	Pe
99.6	7.1	Me
1903.6	6.5	Pi
03.6	6.7	Pt
08.6	7.2	Wh
25.6	6.7	Hu

235120
R Phoenicis

J.D. 242	Est.	Obs.
1870.7	13.5	δ
75.6	13.6	

233209
V Ceti

J.D. 242	Est.	Obs.
1899.7	10.5	Pi
1904.6	11.3	Wh

235350
R Cassiop.

J.D. 242	Est.	Obs.
1835.5	10.9	Lt
73.3	12.2	

235525
Z Pegasi

J.D. 242	Est.	Obs.
1905.5	10.3	Me

235939
SV Androm.

J.D. 242	Est.	Obs.
1924.6	12.3	Y

No. of Observations 1017. No. of Stars Observed 265. No. of Observers 16.

meeting of the Corporation were so arranged that the officers of the Association have become officers of the Corporation. The framed Charter will be hung at the Observatory. The Association is indebted to Mr. M. J. Jordan for attending to the legal measures connected with the incorporation.

The following officers were elected:

President Henry C. Bancroft, Jr., W. Collingswood, N. J.
Vice-President Charles Y. McAteer, Pittsburg, Pa.

Members of the Council for two years

Dr. Caroline E. Furness, Vassar College, Poughkeepsie, N. Y.
Miss Annie J. Cannon, Harvard College Observatory, Cambridge, Mass.

During the recess tea was served thanks to the hospitality of Professor Pickering.

The feature of the meeting was the presentation of a gold paper knife suitably inscribed to Professor Pickering in slight recognition of his kindly interest in, and his efforts to promote in every way the welfare of the Association. The presentation speech was made by President David B. Pickering in which he eloquently expressed to Professor Pickering the appreciation and obligation of the Association.

The following applicants for membership were unanimously elected:—

J. G. Lincoln, London, England.
J. Ernest G. Yalden, Leonia, N. J.
William A. Mason, Philadelphia, Pa.
Arthur C Perry, Brooklyn, N. Y.
S. L. Rhorer, Atlanta, Ga.
Warren H. Cudworth. Assonet, Mass.
Miss Sara B. Downer, Kansas City, Kansas.
Irvin L. Murray, Valhalla, N. Y.
C. Alwyn Mowry, N. Scituate, Mass.

Mrs. George H. Barbour of Grosse Pointe Farms, Mich., was elected a Life Member.

Mr. C. E. Barns of Morgan Hill, Cal., was elected a Patron.

The booklet entitled "The Practical Observing of Variable Stars" published by Mr. Barns, and presented gratis to the Association for distribution, received the hearty commendation it deserves, and the thanks of the association are due Mr. Barns for this generous contribution to promote the best interest of the organization.

The following Honorary Members were elected:—

Miss Henrietta S. Leavitt, Harvard College Observatory,
Professor A. Bemporad, Director of the Observatory, Catania, Italy,
Professor H. C. Wilson, Editor POPULAR ASTRONOMY.
Professor S. A. Mitchell, Director Leander McCormick Observatory, Charlottesville, Va.
Mr. C. L. Brook, Director of the Variable Star Section of the B. A. A., Meltham, England.

The retiring President, Mr. David B. Pickering, read a valuable paper entitled "The Problem of Increasing the Efficiency of the A. A. V. S. O."

On the adjournment of the meeting opportunity was afforded for observing with the 12" and for inspecting the many interesting exhibits of the work of the association arranged by Mr. Campbell, a notable and valuable feature being the reduction in part of Schönfeld's Observations by Mr. J. J. Crane,

The banquet followed, Mr. Leon Campbell acting as toastmaster. Our guest of honor was Dr. H. T. Stetson of the Student's Observatory of Harvard University, to whom the Association is indebted for an invitation to visit the observatory Sunday morning. A number availed themselves of this privilege and thoroughly enjoyed inspecting the many interesting features of this splendidly equipped observatory. An opportunity was given of viewing the solar prominences with the 7½" refractor.

The following members were present at the meeting:—Professor S. I. Bailey, A. B. Burbeck, Mrs. E. T. Brewster, Miss D. W. Block, Miss A. J. Cannon, F. L. Ducharme, Vincent Francis, E. L. Gould, S. C. Hunter, M. J. Jordan, Miss H. S. Leavitt, W. T. Olcott, Professor E. C. Pickering, D. B. Pickering, W. H. Reardon, Miss I. E. Woods, C. T. Whitehorn, Professor A. S. Young.

As the secretary may be away from home this winter Miss I. E. Woods of the Harvard College Observatory staff has very kindly offered to act as assistant secretary. Therefore until further notice members are requested to send their monthly reports to Miss Woods. This will obviate the necessity of duplicating the lists. The work of the secretary will be facilitated if members will send their reports to Miss Woods promptly on the first day of each month.

The annual dues of $2.00 are now payable. Remittances should be sent promptly to the Treasurer Mr. A. B. Burbeck, N. Abington, Mass.

The following members contributed to this report: Messrs. Bouton, Dawson, De Perrot, Hunter, Jacobs, Lincoln, Luyten, McAteer, Meeker, Mundt, Peltier, D. B. Pickering, Reardon, Vrooman, Whitehorn, Miss Young.

WILLIAM TYLER OLCOTT,
Secretary.

Norwich, Conn.
Dec. 10, 1918.

PLATE III

Back Row—(*Left to right*)—W. H. Reardon, F. L. Ducharme, E. C. Pickering, M. J. Jordan, A. B. Burbeck, V. Francis, S. C. Hunter.
Middle Row—L. Campbell, D. W. Block, L. Brewster, A. J. Cannon, H. S. Leavitt, C. T. Whitehorn, E. L. Gould.
Front Row—W T. Olcott, A. S. Young, D. B. Pickering, I. E. Woods, Mrs Gould, S. I. Bailey.

SEVENTH ANNUAL MEETING OF THE A. A. V. S. O. HELD AT THE HARVARD COLLEGE OBSERVATORY, CAMBRIDGE, MASS., NOVEMBER 23, 1918